ASSESSING THE PSYCHOLOGICAL CORRELATES OF BELIEF STRENGTH: CONTRIBUTING FACTORS AND ROLE IN BEHAVIOR

by

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A Dissertation Presented to the
FACULTY OF THE USC GRADUATE SCHOOL
UNIVERSITY OF SOUTHERN CALIFORNIA
In Partial Fulfillment of the
Requirements for the Degree
DOCTOR OF PHILOSOPHY
(PSYCHOLOGY)

May 2012

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Acknowledgements

I would like to thank Dr. David A. Walsh who guided me throughout the development of this manuscript. His theoretical, computational and editorial advice has directed my progress from the beginning. I would also like to extend warm acknowledgements to Jian Li, Edward Lin and Andrew Larsen for their methodological and statistical contributions. I would like to thank my dissertation committee members, William O. McClure, Stephen J. Read, and Justin N. Wood. I would also like to thank my supportive family members, William W. Reser, Cheryl L. Scott, Daniel M. Reser, and Paula J.G. Freund, for their insights and recommendations.

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Abstract

This dissertation examines the psychological foundations of personal belief by conducting a review of classical and contemporary thought about belief, by hypothesizing about ways to conceptualize belief and by presenting new evidence about belief from empirical studies. Two studies measured the contributions of various constructs to belief strength in an effort to examine the determinants and functions of personal belief. Study 1 collected data from over 250 child-parent pairs regarding how beliefs are formulated. Participants rated their strength of belief in statements relative to the following determinants: the importance of substantiating evidence, the perceived logic inherent in a belief, the importance to self-identity, the influence of parents, the social community and authority figures. Study 1 found that strength of certainty can be best predicted by one's estimate of their family member's belief, the quality of empirical evidence that the person can offer to support the belief, and the perceived importance of the belief to their sense of self-identity. Study 2 investigated whether people's weight management beliefs predicted diet and exercise behaviors and whether these behaviors in turn predicted BMI. These expected results were strongly supported by the data gathered from 996 participants, who responded to a questionnaire, reporting their height, weight, beliefs about various aspects of weight management, and personal weight-management behaviors, including exercise activities and eating habits. Overall, 40% of the variance in BMI within our sample, including 49% of the variance in BMI in individuals older than 25, could be predicted by a combination of health beliefs and their associated eating and exercise behavior.

Chapter 1: How to Think About Belief

"It is not disbelief that is dangerous to our society; it is belief"
-George Bernard Shaw

Preface

The longest running and most rewarding adventure of my life has revolved around the discovery, testing and adoption of new beliefs. Scientific curiosity about "how things work" caused me to expose myself to philosophical positions that uprooted some of my earliest, most cherished beliefs. Religious agnosticism, psychological materialism, scientific reductionism, moral relativism and physical determinism have replaced beliefs that I have guarded since early childhood. The act of exposing a belief to rational criticism, and being compelled to overturn and replace it, felt incredibly exciting and constructive. At some point though, I realized that I had been constructing beliefs about scientific concepts without actually knowing any of the science behind belief. This dissertation is an attempt to better understand my own beliefs, how I came to acquire them and how to guard against mistaken beliefs in the future.

The literature review includes a brief description of how other researchers have thought about how beliefs are formulated and how and when they are subject to change. Many different contributors to certainty strength have been recognized by previous theoreticians and researchers over the years and the present study has attempted to examine the most meaningful and compelling of these constructs. Several factors that affect belief are identified such as: empirical evidence, logical thinking, competing evidence, opinion of parents and friends, opinions of authorities, the influence of

experience, the bearing on self-identity, general likeability, expected permanence and perceived relevance. Previous research on belief formulation has explored how existing beliefs affect decision making and cognition but researchers have not investigated how individuals appraise different components of belief certainty relative to each other. The results of the experiments conducted by the author, found in the final chapters of the dissertation, suggest that that strength of certainty can be predicted by the quality of empirical evidence that people can offer to support the belief, by their estimates of their parent's certainty in the belief and by the perceived importance of the belief to their sense of self-identity. Overall, the dissertation examines the fundamental question "why people hold the beliefs they do" by delving into the physical, social and religious beliefs of individual people and determining how they support, rationalize, think and feel about the beliefs they hold.

Introduction

What determines belief? How do beliefs form and what circumstances influence people to change them? How can beliefs be accurately described in terms of other, pertinent psychological and neuroscientific phenomena? Although beliefs play an instrumental role in all human activities and are highly consequential for individual and societal behavior, there are no accepted mainstream or even academic answers to these straightforward questions. In the search for answers, where does one begin?

The pertinent scholarly literature is scarce and inconsistent. Actually, belief may be unique among common, psychological constructs because of the absence of any broad synthesis of its terms. To advance toward such an understanding it is necessary to borrow

from a number of different approaches and disciplines, and to integrate and reconcile. Areas, such as social psychology, cognitive psychology, philosophy of mind, epistemology, linguistics and cognitive neuroscience, all make contributions; yet unlike other fundamental psychological constructs, there seems to be little explicit reconciliation between these contributions for beliefs.

This review will attempt to draw from a number of different sources in the sciences and humanities to offer a description of previous treatments given to belief, to reconceptualize the matter given the new perspectives, and to identify unknowns for future study. Research on the dynamics of belief will be emphasized over semantics and statics. The best way to study something as elusive as beliefs is probably to observe them in action - during formation and change. To this end, the focus of this research is to analyze both theoretical and empirical work on the foundation and plasticity of beliefs in the hope of furthering our understanding of this highly consequential, natural phenomenon.

Psychology and related disciplines have treated the construct of belief inconsistently. Due to its ubiquitous use as a psychological construct, in folk psychology and everyday life, it has been resistant to scientific operationalization. Belief is often discussed but left undefined, and several well-received definitions are not only inconsistent but also mutually contradictory (Furinghetti & Pehkonen, 2002). There is no consensus concerning what criteria a thought must meet to qualify as a belief (Eichenbaum & Bodkin, 2000). However, certain conventions are generally adhered to in

the literature. Generally, a belief is treated as a fundamental mental representation, and therefore, a basic unit of cognition.

Belief is usually held to be the psychological state in which a person holds a proposition, perception, inference, judgment or premise to be true (Green, 1971). Beliefs can be created at the time they are needed during an activity or constructed presumptively to account for a past event or to prepare for a future state of affairs. Talk of a belief necessarily supposes an entity (the believer) and a proposition (the object of belief). It also presupposes that the belief may not be well supported enough to constitute true knowledge - that it is a conjecture or hypothesis (Abelson, 1979). Belief involves conviction, possibly even devout conviction, but does not necessarily involve certainty. Moreover, beliefs can be held about common workaday concepts but are usually invoked in matters of importance or where there is a divide in credence. Thus beliefs often involve stances on consequential topics, such as morality, faith, politics, science, personal identity, history, religion, distribution of wealth, economics, or culture.

How beliefs are formulated and what protocol people use when formulating them is an issue of contention, but also one of curious speculation and wonder. There is no accepted "unified theory" of belief formation, and most researchers that endeavor to grapple with the concept write about it as if it is mostly uncharted territory. Aside from Plato's early work on belief justification, there is only patchy common ground. In his often cited dialogue, *Theaetetus*, Plato asserts that reason (personal logic), evidence (empirical support), and guidance (social influence) provide the best justification for a new belief (Cornford, 2003).

Psychologists have consistently identified these three contributors - reasoning, evidence and the beliefs of others - to be among the most important determinants in belief justification (Abelson, 1986b). Information relevant to how people search for these, how they think about them and how they use them are essential to grasping belief formation and change. We will focus on the constructive contributions of Plato's logic, evidence and social influence here but also consider what happens when these factors fail to guide belief properly.

Most people assume that their beliefs, especially when they involve matters of importance, are chosen conscientiously with a good amount of deliberation and reasoning. This paper will consider several sources of evidence suggesting that often, even consequential beliefs are chosen with very little declarative rationale and poorly supported by critical thinking. Several fundamental mistakes of belief formation will be examined, including the use of biases, fallacies, faulty heuristics and irrational tendencies (such as the inclination to give preferential treatment to concepts that come to mind more readily). One reason beliefs often evade systematic justification may be that much of the cognitive process of analyzing and accepting a belief is below the level of conscious awareness. Individuals often only have insight into mental processes that are guided by consciousness; unfortunately, adults have been automating aspects of believing since early childhood and becoming aware of these aspects can be very difficult after they are made implicit. Even into adulthood, many false beliefs probably come about, unjustified, due to a questionable association between two stimuli in the environment that should be interrogated further, but is not.

As associations that take place in the brain, beliefs are not exclusively the province of psychology. The neurobiology of how these associations occur, in terms of neurons, synapses, binding and neuroanatomic space, will be discussed. The cortical and conscious correlates of belief will be investigated and the existence of belief in non-human animals will be considered. Derangements in the proper neurobiology of belief, often result in deranged belief. Psychologically and/or biologically impaired belief development can lead not only to false beliefs but also to the debilitating and socially damning delusions of psychosis and dementia.

Hasty or incomplete belief formulation can lead people to espouse beliefs that are unfounded. It seems that the way that humans are hard-wired, it is easy for them to become convinced of something and even to act on this conviction, without going through pertinent intervening operations, such as citing evidentiary facts or articulating logical arguments. People routinely fail to search for and evaluate evidence, even when forming their most cherished beliefs (Tavris & Aronson, 2007). Sometimes such evaluations are clouded by snap judgments or emotions, which have the capacity to cause us to become inordinately invested in a restricted subset of concerns without considering contradictory information. “Feelings of certainty” are often responsible for premature conviction and their derivation, emotional concomitants and validity are evaluated here. Interestingly though, new research has shown that emotionally driven judgments can be constructive and even advantageous in certain situations (Gladwell, 2005). Many beliefs that are not analyzed conscientiously, or even consciously, may still be good beliefs. A large body of recent literature has shown that, when made within one’s area of expertise,

snap judgments, hunches and intuitions can often lead to better answers than analytical investigations (Gigerenzer, 2007). Such beliefs are also much faster. Choosing what to believe, especially when one feels obligated to deliberate carefully, can be time intensive and exhausting. Clearly, there are tradeoffs involved in belief formation involving accuracy, efficiency and expediency.

When someone realizes that their beliefs lack logical and evidential support, they often choose to appropriate beliefs from others. This is usually done when a belief is too complex or unfamiliar; when someone does not have the skill or knowledge base to think about it on their own. It seems that parents are a substantial source of belief for their children, especially early in life. It is unclear though, how mothers and fathers transfer their beliefs and whether children can accurately gauge their parents' true sentiments. Surely the social process of believing varies by belief. For beliefs of low or moderate complexity, people often side with their parents or close friends. For beliefs of high complexity though, many people feel compelled to side with a specialist in the pertinent field, such as a scientist or philosopher. As we will see, people use a variety of heuristics when deciding from whom to borrow ideas. Sometimes this borrowing is unintentional. People can be unaware of the influence that others have on their beliefs. In fact, it is possible to be oblivious to the impact of persuasion, even when being persuaded coercively. Overall, it seems that many beliefs are the outcome of social pressures, a need to fit in with others and tacit and unacknowledged expropriation.

In the pages that follow, we will elaborate further on the subject of belief formation and change from a wide range of perspectives. We will consider how beliefs

are affected and constrained by attitudes, fallacies, heuristics, delusional thinking, intuition, neuroscience, personality, persuasion, unconscious factors and self-identity. These concerns will be traced back to the processes of belief formation and change, focusing on the cognitive aspects of belief inception, endorsement and assimilation. Where possible, we will draw inferences about belief from experimental studies and data collection efforts. At this point in the evolution of belief research, however, we are highly reliant on speculation, anecdote, personal observation and convergent validation. It is not clear how much of this information can be neatly coordinated into a unified theory of belief, but considering the existing knowledge about belief in this way should constitute a good starting point. Overall, it is clear that the study of belief change is truly multifaceted, should be intensely scrutinized and deserves much wider study.

Chapter 2: Belief as a Construct in Psychology and Philosophy

"I would never die for my beliefs because I might be wrong
-Bertrand Russel

The early psychological literature on attitudes and the age-old literature on philosophy of knowledge, have substantially contributed to the demarcation and exposition of what it means to believe. Systematic examination of beliefs began in the early 20th century by psychologists, mainly in the arena of social psychology (Thompson, 1992). Much of this research was actually conducted with the intent to study the volatility of attitudes and the power of persuasion, but the research was cut short. Behaviorism, with its emphasis on observable behavior and ridicule of the study of cognitive processes, ended most of the early research on beliefs and belief systems. As new developments in cognitive psychology began to arise in the 1970s, interest in beliefs reemerged as behaviorist ideology dwindled (Abelson, 1979). Around this time, beliefs began to be viewed as conclusions about phenomena and their nature that both affective and logical factors impacted (Green, 1971). The study of attitudes was resurrected and for quite a while the best place to look for research on beliefs was in the literature on attitude formation. Thereafter, the link between belief and attitude was made explicit (Underhill, 1988). Despite the fact that the relationship between these two concepts has not been entirely clarified, we will consider some of the research efforts and theoretical work within this area in the section on attitudes.

Philosophical thinking on belief is much older than the psychological research. This research, historically, has also been more insular and more exploratory though. Some philosophers believe that 'belief' cannot be defined, is not equivalent to the content of any definite description and is difficult to describe in terms of its essential and accidental properties (Hay, 2008). Philosophy has tended to be relatively abstract and inconsistent in its treatment of beliefs whereas in psychology, a data driven pursuit, less is written on the definition of belief but there is more agreement as to what constitutes a belief (Green, 1971). The two disciplines contribute differently, but substantially, when taken together.

Both the philosophical and psychological literature emphasize that most people distinguish what they know from what they believe even though they consider both kinds of statements to be true (Schwitzgebel, 2006). This distinction between belief and knowledge originates from the philosophy of mind where it is a seminal concept. Both psychologists and philosophers concur that belief systems often include a substantial amount of episodic material from personal experience, folklore, cultural doctrine or propaganda and contain strong references to the self-concept of the believer, a feature usually left out of knowledge systems completely (Abelson, 1979). In addition, beliefs can be held with varying degrees of certitude; one can be passionate or restrained about a belief, whereas with knowledge you know something to be a fact or not. This difference, where only beliefs can vary in certainty, leads many beliefs to become subjects of powerful emotional or subjective feelings. The interrelationship between beliefs and personal concerns is a potentially rich but mostly unexplored topic that will be elaborated

on in the section on self-identity. Empirical research has made it clear that a person's past, occupation, habitual activities, pride and ego all play a role in what they choose to believe (Furinghetti & Pehkonen, 2002). In fact, the involvement of concerns related to selfhood and individuality are a major factor that differentiates things that are believed from things that are known.

A knowledge system is a set of proven facts that are accepted to be true; whereas, a belief system is a set of nomologically related propositions that one holds to be true but may not have been scientifically proven or sociologically accepted. There are caveats to this though. Cognitive psychologist Robert Abelson (1979) has asserted that if every normal person of a particular culture believes in an unproven supernatural construct, even though this might constitute a false belief system to an observing anthropologist, it would constitute a knowledge system for the members of this culture because of the unanimity of belief. This brings an interesting concept into play, mainly that belief may be distinguished from knowledge on the basis of either scientific grounds or by cultural consensus. Most philosophers though, agree that a scientifically false belief should not be considered knowledge even if it is totally sincere (Abelson, 1986a). Conversely, a truth that is not believed by anyone does not constitute knowledge because for it to be knowledge, a person must believe or know it. Equivalently, a person must believe a belief for it to exist, even though according to some theorists, a person may hold a specific belief, but not know it until they are forced by experience to formulate the belief consciously (Hay, 2008).

There are other important facets to the relationship between knowledge and belief. Knowledge requires belief, so it is epistemically impossible to know something but not believe it. On the other hand, belief does not require knowledge nor does knowledge about a particular belief necessarily constitute an endorsement of it (Abelson, 1979). Often statements about belief entail faith such as a person believing in his or her favorite sports team. This has been called "belief in" which indicates faith in something and is usually commendatory or exhortatory (I believe in the power of love). Such beliefs refer more to inner states of opinion than they do to an outer reality. Epistemology and psychology have historically been less concerned with this type of belief and more concerned with beliefs that can be formulated into subjective, personal statements on topics involving knowledge more so than faith (Hay, 2008).

Plato and Socrates made what is regarded as an important distinction between knowledge and belief, saying that knowledge is a direct perception of information about the world and that belief is the qualification we put on the accuracy of that perception. Plato in *Theaetetus* defined knowledge as "justified true belief (Cornford, 2003)." Since this time, philosophers have seemed to relish the distinction between knowledge and belief. This topic is interesting because it details how we piece our worlds together from phenomenal experiences. The topic, known as epistemology- the philosophical study of how humans use knowledge to justify beliefs - is a highly influential discipline that appears particularly germane in our discussion of beliefs.

Chapter 3: Personal Epistemology

"The outside world is something independent from man, something absolute, and the quest for the laws which apply to this absolute appeared to me as the most sublime scientific pursuit in life."
-Max Plank

Epistemology is the branch of philosophy concerned with the nature and scope of knowledge. Since epistemology is concerned primarily with determining what criteria must be met by conjectures for them to constitute true knowledge, understanding it should help us to better understand beliefs. A comprehensive account of the important constructs in epistemology would be pedantic yet a review of its foundations should help to elucidate the problems encountered by people who are trying to decide what to believe and bring us closer to an understanding of the cognitive basis of belief formation and change.

Opposing epistemological camps have helped to delineate ground rules for how to think about beliefs. These camps have taken strong, opposing positions but in doing so have generated and expounded upon fundamental viewpoints, most of which are not necessarily incompatible with one another. Foundationalism represents the notion that basic statements that cannot be falsified are self-evident and self-justifying, do exist and give justificatory support to other derivative statements, creating a foundation for a structure of knowledge. The doctrine of Fallibilism contradicts this assertion, arguing that absolute certainty about knowledge is impossible and that all claims of knowledge, in principle, could be incorrect. This nihilistic stance, where there is thought to be no

objective basis for truth, is not widely embraced but has never been satisfactorily dismissed either (BonJour, 2002). Empiricists counter that it is possible to lay a foundation for knowledge, and they insist that reports of sensation are the source and criterion for knowledge. This empirical stance holds that sensory knowledge is indubitable and can constitute epistemologically basic propositions (this will be discussed further in the section on evidence). This tradition, along with rationalism, has formed the foundation for modern science. Rationalists argue that true knowledge does exist and is gained by reason but not by experiences. Rationalism is concerned with the logical paths to knowledge and much of this literature involves the identification of fallacies that interfere with or obfuscate logic. Here, to be reasonable, it is necessary that one's rationale has not committed to a fatal falsity.

In the study of logic, a fallacy is defined as a misconception resulting from incorrect reasoning in rhetoric or argumentation (Hay, 2008). Fallacies include mistakes in argument such as false dichotomy; appeal to common opinion; confusion of cause and effect; drawing the wrong conclusion; appeal to emotion; misuse of a vague expression; begging the question; false alternative; faulty analogy; omission of key evidence and use of a red herring. Importantly, fallacious arguments are thought to be used often to support belief (BonJour, 2002). Although some fallacies are specific to arguments between two people and could probably not be generalized toward an "argument" someone is having with themselves, personal beliefs are highly susceptible to common fallacious logic (Dancy, 1991). Rationalism has produced these tools of logic which can be used to assay the justification for individual beliefs.

Rationalism, Empiricism, Foundationalism and Fallibilism are each extreme stances that allow important insight into how beliefs are generated and supported. Commingling the messages from these schools of epistemological thought allows us to see that good logic and trustworthy evidence can combine to erect a sincere and credible belief system despite the fact that a degree of uncertainty will remain. Popular and recently derived models of epistemic decision making map out how these stances affect individuals when they are deciding what to believe. One particularly successful model, the Reflective Judgment Model, illustrates how personal epistemic reasoning can attempt to avoid fallacy and falsity.

The Reflective Judgment Model (RJM) is a theory of human decision making designed to describe the development of reasoning by detailing how epistemic assumptions change and how critical and reflective thinking skills inform belief. The model has been supported by extensive longitudinal and cross-sectional research and routinely informs the work of developmental and educational psychologists (King & Kitchener, 1994). Reflective Judgment emphasizes that many problems cannot be solved with certainty, that people know this and that they create strategies for dealing with uncertainty. As they do this, they move up through a hierarchy of many stages of proficiency that are divided into three main categories. The categories correspond to modes of reasoning which are thought to develop in an invariant sequence: prereflective reasoning, quasi-reflective reasoning and reflective reasoning.

Prereflective reasoning mediates the acquisition of beliefs through the word of an authority figure or through firsthand observation. People who use this type of reasoning

do not question their beliefs and assume that they know things with complete certainty. A person who uses quasi-reflective reasoning appreciates that knowledge claims contain elements of uncertainty and uses evidence to support their beliefs but they are inconsistent, idiosyncratic and subjective in their epistemic reasoning. Reflective reasoning, on the other hand, is much more objective, is open to continuous reevaluation, is conscious of the pitfalls of fallacious reasoning and is never certain but operates on the basis of the "most reasonable" evaluations of available data. RJM provides a fine model for different degrees of experience and acumen in belief formation and change. By emphasizing the importance of comfort in the absence of certainty and openness to constant reevaluation of the same beliefs, RJM sets a high standard and gives most believers a lofty goal to aspire to.

Another popular paradigm discussed in the literature on belief formulation, the Data-oriented Belief Revision (DBR) model, is consistent with this interpretation (Paglieri, 2005). DBR operates on the assumption that data and beliefs are two separate entities. Under this model, data are snippets of information collected and arranged by an individual and beliefs are interpretations of the arrangements of this data that have been accepted as true. According to this paradigm, and consonant with a good deal of other research perspectives, a large number of logical, emotional and cognitive-developmental determinants are thought to play roles in whether data is accepted or rejected (Paglieri, 2005). This is similar to RJM, and other models of belief because DBR's conceptualization of data is practically equivalent to the former's concept of knowledge. Other epistemological models feature various other concerns but none brings them all

together. Creating a comprehensive model of the process of belief and believing is an endeavor for the future.

Personal epistemology, a subject still being formalized, maps out how individuals conceive of and use logic, evidence and other people to assemble and fortify their belief systems. Empirical studies have supported that there are degrees of maturity and effectiveness in using epistemological reasoning (Perry, 1970). This research has evaluated participants on a variety of levels corresponding to the constructs in RJM and shown that a large degree of interpersonal variability in skill with belief exists. This research led its principle investigator, William Perry (in his scheme of intellectual development), to point out that mature people realize that not all questions have verifiable answers, that some contentious issues are truly only a matter of opinion and that even distinguished authorities can disagree on certain topics (1970). It is clear that some statements can be proven, others can be strongly supported, others can only be bolstered and that judicious and discerning individuals can perceive and apprehend the difference. Every believer should benefit from being exposed to these enlightening epistemological considerations. Other informative doctrines of epistemology that potentially could and perhaps should be reconciled with the notion of belief include agnosticism, determinism, fatalism, nihilism, skepticism and solipsism. Personal epistemology is a topic that will pervade our discussion of beliefs for the remainder, especially our examination of the role of evidence and logic.

Chapter 4: Empirical Evidence and Logical Reasoning

"The wise know too well their weakness to assume infallibility; and he who knows most, knows best how little he knows."
-Thomas Jefferson

The use of evidence and reason in guiding belief has been a topic of foremost concern in scientific methodology. For thousands of years philosophers of science have been active in rationally examining the nature of belief derived from observational research (Bechtel, 1988). Aristotle contributed appreciably to the understanding of how data could lead to classification, theory and knowledge. His ideas on the matter were preserved and conformed to for over a millennium despite the fact that they were less than comprehensive. Aristotelian science was subject, in a haphazard way; to the rules of natural philosophy where naturalistic observations could be analyzed using the philosophical method of one's choosing. Since the 17th century, Francis Bacon, Rene Descartes, John Stuart Mill and the Logical Positivists have greatly improved upon the old philosophical methods of syllogism, transitive inference, metaphysics and ontology with more algorithmic methods of science. The modern scientific method espouses the view that empirical evidence is indispensable for knowledge of the world and that scientific beliefs must be justified by strong physical evidence, materialistic induction and deduction and the systematic testing of alternative hypotheses.

Although the scientific method acts as a good model of belief epistemology, its methodology is too rigorous and exhaustive to be practical for personal beliefs. People need a quicker more direct way to justify their beliefs. It is probably a safe bet to base

one's beliefs on the beliefs of scientists but much scientific thought takes voluminous reading to uncover and many things that people want to form beliefs about have not been subjected to scientific inquiry. Instead people often rely on personal observations, the opinions of secondary sources, authority claims, social or cultural consensus and the coherence of argumentation (Irving et al., 1998). Personal observations are usually trustworthy unless the perception involved was illusory or the person attempts to generalize an observation inappropriately. Secondary source evidence such as photos, videos, or reports are often credible except when they are manipulative or misleading. Authority claims and social consensus can differ but are both taken as reliable by most people (Ross & Anderson, 1982). Logic, reason and the coherence of arguments are usually, at least, taken into account by people deciding what to believe. But precise logic, which involves the forming of premises and deducing valid conclusions from them, is laborious (Abelson, 1979). Every person probably has their own idiosyncratic methods of using logic and evidence, and these methods themselves are probably used inconsistently.

Most people think that their unique way of justifying beliefs is valid. They assume the beliefs that they choose to espouse are those that are consistent with sensory perceptions, sociologically accepted systematizations and dedicated reasoning. These people may be sincere and even sensible in thinking that the manner in which they choose what to believe is logically permissible but there is a good deal of research suggesting that most people hold a multitude of beliefs that are not supported by evidence or well-reasoned argument (Kida, 2006).

Empirical studies have examined the role of evidence and reason in guiding personal opinion and have demonstrated that they are often used inconsistently and inappropriately (Schommer, 1990). Schommer administered an epistemological questionnaire to undergraduates and found that students that simplify their searches for evidence too much tend to be overconfident in their comprehension and tend to reach oversimplified conclusions. Further, she discovered that students that frequently use irrational epistemological reasoning are more likely to reach inappropriately absolute conclusions when asked to write a concluding paragraph to a passage about scientific findings. In fact, a growing body of literature indicates that our beliefs, and or certainty in them, may be guided more strongly by emotional construals, transient motivations, subjective biases, subconscious objectives and constructs tied to self-identity (Tversky & Kahneman, 1974). This can be good or bad, depending on the belief in question.

Many researchers advocate that emotions (in the form of conditioned visceral reflexes, amygdalar responses or orbitomedial prefrontal cortex biases) can cause people to jump to accurate conclusions without need of employing the intervening cognitive steps (Damasio, 1994a,b). Other research in this area shows that evidence may not be necessary when it has already been gathered, when it is implicit in an emotional response, when good evidence cannot be found, or when too much evidence leads to "analysis paralysis" (Gladwell, 2005). Spontaneous decisions or snap judgments can be helpful in such situations, but this is more often true of one-time decisions than permanent beliefs. A decision is usually particular to a situation; whereas, a belief is often formed because of

its utility in multiple situations. When beliefs are constitutional, when it is clear that they will guide future behavior, they should be made deliberately and not spontaneously.

The philosophical literature on "evidential belief" makes a distinction between core beliefs and dispositional beliefs. Core beliefs are propositions that have been considered or decided upon in the past. Any core belief has been thought about actively at one point. A dispositional belief is a belief that someone might ascribe to if confronted with a topic but has never considered the topic before and therefore has not come to a belief about the topic in the past (Bell et al., 2006). Dispositional beliefs have not yet had logic or evidence brought to bear on them. It is thought that dispositional beliefs, when formed, are more likely to be contrived hastily and, relative to beliefs that have some kind of precedent, are not as adequately supported. Another similar view of belief revision explains that keeping consistency among our beliefs is a basic human need and an urgent concern during belief formulation (Schick & Vaughn, 1995). Pencil and paper studies evince that people tend to reject facts or statements that are at odds with core beliefs that they have chosen to espouse or support in the past (Schick & Vaughn, 1995). For this reason, many people will embrace evidence that supports a held belief and disregard evidence that conflicts – regardless of merit - in order to maintain cognitive consistency (Dancy, 1991).

The philosophy of belief source has elaborated on two approaches: the foundation model and coherence model (Doyle, 1992). According to foundations theory, beliefs are maintained if they are reasonable, rational and justified, and beliefs are abandoned as an individual adopts evidence to the contrary. The coherence approach, in contrast, contends

that an individual will accept a belief if it logically coheres with other closely held beliefs pertaining to self. Some beliefs may be more important, or psychologically central, for a person than others and so new beliefs are probably tested for coherence with these first (Pehkonen, 1994). Core beliefs are usually affected by both. The foundational and coherence models are thought to be able to coexist and lead to the following situation: the availability of rational and justified evidence will combine with personal relevance of the belief to determine certainty strength or degree of conviction. Like DBR and RJM, these approaches can be used to inform predictions about how humans will make decisions under different evidentiary conditions (Doyle, 1992).

Mathematicians have contributed to the debate about human beliefs and proposed prescriptive models of how a person's belief should change in strength when they are presented with new evidence supporting or refuting a belief. Bayes' Theorem has been used to describe how the strength of a rational person's beliefs should change when they combine new evidence with previously accumulated evidence (von Winterfeldt & Edwards, 1986). In fact, the field of Decision Analysis was born in 1954 when Ward Edwards, asking participants to revise their existing beliefs after being exposed to new evidence, demonstrated that human decision makers depart greatly from the mathematical predictions of Bayes' Theorem (Edwards, 1954). Most people were never instructed how to use evidence rationally and we cannot expect them to operate under mathematically optimal conditions. Also, people do not normally calculate probabilities, they compare an imagined scenario employing a given belief to a scenario without the belief.

Descartes and Spinoza had different ideas about how evidence plays a role in belief. Rene Descartes described beliefs as involving two mental representations, one regarding the claim at stake and another that exposes this claim to assessment and scrutiny. He thought that evidence played a major role in this assessment. Importantly though, he maintained that beliefs are held and analyzed objectively until the person chooses to accept or reject it (Clarke, 2006). This view dominated until Baruch Spinoza argued that in order to assess a belief we must first comprehend it and in order to comprehend it we must accept it (Boucher, 1999).

Some functional magnetic resonance imaging (fMRI) data have supported this notion that in order to question a belief we must, at least momentarily, accept it as true (Harris et al., 2007). Others have taken this idea further and pointed out that because we must believe a belief in order to understand and analyze it, perhaps sometimes we believe falsely because we have begun, but not finished, the process of belief formation (Gilbert, 1991). Studies have shown that merely being exposed to a statement, like leading questions from an unethical lawyer, can induce belief. Other studies have shown that distraction or time pressure can make people prone to accepting a falsehood (Schick & Vaughn, 1995). Ironically, failing to properly bring good evidence to a claim, in some circumstances, can make us more likely to believe it.

Wimmer and Pemer (1983) have elaborated on Spinoza's position and asserted that in order to analyze an incoming belief we must construct two completely separate models of the world: one in which the information is true and one in which the information is false. It is not clear if this is true or not but certainly, the ability to create a

different model of the world can act as a frame of reference helping us to better understand, interpret and predict the actions of someone whose beliefs differ from our own. It would be interesting to find out more about how individuals employ working memory to represent, model and test probationary beliefs. That very little research has been done here and that few have attempted to verify or disprove these philosophical ideas is exciting for younger generations of researchers.

When we act on intuition, instead of employing working memory, we may be relying on evidence that was acquired in the past but is now preconscious. Certain behaviors, even ones that we are not aware of, can become routinized and automated to reflect entrenched beliefs that, in the past, were based on true evidence. For example, one might have a predilection to treating strangers kindly without having to reactivate previously held convictions about altruism. Just as good posture can be maintained by muscle memory, personality, general demeanor, belief propensity and even decision styles can be maintained unconsciously. Many beliefs that have influenced behavior in the past probably become phased out of consciousness as they are incorporated into automatic subroutines. When held accountable for explaining why they acted in a certain way, one may not be able to invoke the original belief despite the fact that it did powerfully, albeit indirectly, influence behavior. It is probable that young children become explicitly aware of some of the cognitive protocol involving belief formation, but after repetition and practice in using beliefs, these formal rules become procedural, and thus, lost to conscious awareness. These explicit rules of belief and knowledge acquisition are effectively retained in the sense that they continue to determine belief

outcome, but, because they have been made implicit, they are unavailable for personal or even scientific scrutiny. For this reason, attempting to pry loose the integral elements of belief, especially in early life, should help us attain a comprehensive model for belief dynamics. The section on the influence of other people will consider from whom and how we extract evidence.

Research shows that individuals will often maintain a belief in spite of overwhelming amounts of contradicting evidence and this tendency is termed "unwarranted theory perseverance." After performing several survey studies and an extensive literature review, Anderson et al., (1980) concluded that people frequently cling to beliefs to a, "considerably greater extent than is logically or normatively warranted." Their findings and the findings of others suggest that evidence is often not measured judiciously and that competing beliefs and counter explanations are too often ignored or overlooked (Kida, 2006; Schick & Vaughn, 1995). The ability to guard against hasty belief has been called "source monitoring" by Marcia Johnson (Johnson, 1999). This ability is thought to be multifaceted and proficiency is said to take experience and practice (Johnson, 1999). Ability at source monitoring is thought to be a function of a person's awareness of and refusal to commit the common mistakes of belief formation.

Chapter 5: How Believing Goes Wrong

"I do not consider it an insult, but rather a compliment to be called an agnostic. I do not pretend to know where many ignorant men are sure -- that is all that agnosticism means." - Clarence Darrow

When forming beliefs, people use processing shortcuts, or heuristics, which work in some situations, but also lead to mistakes if they are used inflexibly. Several popular books have been written on the topic of cognitive blunders and it seems that the public has an appreciation for, or at least an interest in how to recognize and correct common mental lapses. According to Thomas Kida (2006), these mistakes include human tendencies to: prefer stories or anecdotes to statistics; be confused by superficial similarities; give preferential treatment to concepts that come to mind more readily; seek to confirm though not to question ideas; disregard alternative explanations for phenomena; accept flimsy evidence to support an extraordinary claim; underemphasize the role of chance and coincidence in shaping events; misperceive; oversimplify; and have faulty memories. Several of these mistakes are congruent with specific logical fallacies identified by philosophers. These are a somewhat arbitrary and motley grouping of blunders, but because psychologists (Kida, 2006; Tversky & Kahneman, 1982) have emphasized them routinely, we shall briefly consider each in an attempt to glimpse how beliefs go wrong.

People have a tendency to prefer stories or anecdotes to statistics. Stories are probably easier for us to understand; they seem more salient and more reliable even though they are usually less reliable than statistics garnered by intensive experimentation.

Cognitive science has evinced that people often find themselves in situations where it is necessary to employ statistical reasoning to solve problems or make intelligent estimates. Most people have difficulty using statistical information effectively; consequently, they will often use other "heuristics" to help solve problems. Kahneman and Tversky (1974) studied these phenomena in depth by measuring people's performances on carefully devised assessments. They wanted to see what rationale people used to make decisions, especially decisions related to determining the relative frequency of specific events. Representativeness heuristic and the availability heuristic were two heuristics they found thought to have a substantial bearing on beliefs. The representativeness heuristic is used when we judge two things as being similar only because they share prima facie characteristics, or a superficial resemblance. People using this heuristic ignore statistical rules and assume that if one concept shares a specific quality with another concept that these two concepts are sure to share many other qualities and should be categorized together (Tversky & Kahneman, 1982). This heuristic is very similar to the fallacy of "faulty analogy" mentioned earlier. Both are thought to be responsible for why many people see illusory relationships in a series of random events. In addition, when applied incorrectly, the representativeness heuristic is known to lead to the creation of damaging stereotypical beliefs (Kahneman & Tversky, 1973).

The availability heuristic is similar but distinct from the representativeness heuristic. Many psychological experiments have shown that people regularly use "available" or easily accessible memories to make judgments about the likelihood of events. This is probably because it is natural for us to use concepts that readily spring to

mind rather than complete and unbiased information. We can easily remember recent experiences or reports from friends and the news, and we often use these types of information instead of using statistical information to estimate probabilities (Tversky & Kahneman, 1973). The fact that prejudiced information is more readily available to memory causes us to discard more reliable empirical knowledge and thus, leads to unobserved, hasty beliefs. Researchers have pointed out that throughout its evolutionary history, our species has gained knowledge from personal anecdotes or memorable occurrences, not from statistics or experimental studies. Many researchers believe that this partly underlies our penchant to pay close attention to information coming from a story, a personal account, or an associated experience (Shermer, 1997). This tendency has the effect of making us believe in causes that are really only partial causes, accept things that are unsubstantiated, and trust small sample sizes (Sagan, 1995).

We also seek to confirm our beliefs. People have a strong penchant for committing the confirmation bias or the positive-test strategy, where they are prejudiced towards confirming their speculations. This is a common cognitive error that biases us toward confirming our ideas by making us seek out cases that support our hypotheses and disregarding cases that question them (Shermer, 2003). This proclivity acts to reinforce existing beliefs and plays a large role in the maintenance of delusion, in attitude polarization, and in illusory correlation (Charles & Lodge, 2006; Lee & Anderson, 1982). Related, the behavioral confirmation effect, also known as the self-fulfilling prophecy, occurs when a person's expectations influence their own behavior, which can lead to disastrous decisions in organizational, military, and political contexts (Darley & Gross,

2000). These examples show how powerful expectations can be in influencing our decision-making strategies.

Expectations have even been shown to influence perceptions. When a newsflash in a small town reported that a large bear had escaped from a local zoo, the 911 switchboards lit up. People reported seeing the bear all over town, despite the fact the bear never wandered more than 100 yards from the zoo (Harter, 1998). In a similar way, sports fans have been shown to be functionally blind to infractions committed by their own team (Hastorf & Cantril, 1954). People expecting to deduce the rules used in a video of a ball-passing game have an attentional scotoma for the appearance of a man in a gorilla suit, simply because his presence was not expected and thus, was not attended to (Simons & Chabris, 1999). Other experiments with selective attention have shown that people can be functionally blind to highly salient stimuli if they are concertedly attending to other stimuli (Knudsen, 2007). These and many similar anecdotes and experimental outcomes embody the lyric, "what a fool believes… he sees." Expectations can have powerful effects on perception, and it is thought that misguided perceptions also have the capacity to lead to false beliefs (Kida, 2006).

The hindsight bias is another, related mistake that has the potential to impinge on both memory and belief. It is common for people to recall their correct predictions but to forget about the faulty ones (Fischhoff & Beyth, 1975). The dramatic fervor that fans display for their team is rekindled after a win but quickly forgotten about after a loss. When a situation is playing out, an individual might throw in a quiet remark about their prediction for a certain event. If they lose, the remark is forgotten. If they win, they can

then speak vociferously about their "uncanny" prediction. Often an attempt to gain credibility, this tactic can confuse even the speaker because it gives them an erroneous conception of probability and of their own ability to predict random events.

Many psychological models of memory impairment attempt to explain how this type of cognitive error might stem from a few different causal factors. Some psychologists think that knowledge about the outcome of an event might alter or erase previous memories related to the event before it played out (Fischhoff & Beyth, 1975). Motivational factors and factors related to the heuristics used in recalling events might make the original judgments or beliefs less easy to activate (Morson, 1994). The hindsight bias, much like many of the phenomena described by psychologists, to many people seems to be trite or "common sense." This view is influenced by the hindsight bias, the tendency to see things as obvious, but only after the fact.

Faulty memory can lead to mistakes in belief formation. Memory recall was once thought to be a highly accurate and automatic process in the sense that it ran to completion via subconscious mechanisms, and thus was hard, if not impossible, to bungle up. Now, recall is often conceived as a subjective process, where people use working memory and executive functions to piece together past events. Memory recall thus involves conscious deliberation and, because of this, is open to all sorts of processing errors. Memory is often thought to be patently veridical, but when it is not – when it is reconstructive – it is fallible.

Confabulation is a common error that can be made during recollection. Confabulation is the spontaneous and unintentional narrative report of events that never

happened. When confabulations involve recollection, it is the confusion of imagination with memory or a confusion in the application (or integration) of true memories (Berrios, 1999). Confabulation is an indicator of psychosis or frank delirium but is thought to occur in a less prominent and less understood way in all people. Daniel Schacter's (2001) book *The Seven Sins of Memory* points out seven common problems with memory or its use that can result in mistaken thinking. These involve the transience of many memories; the consequences of absent-minded thinking; the tendencies of certain memories to interfere with or block the recall of other related memories; the misattribution of source; the intrusive persistence of memories that are impertinent, unwanted or disturbing; and the corruptibility of memory by suggestion; and bias. Beliefs are necessarily predicated on memories, and thus, when memory is obscured or blatantly erroneous, belief accuracy can be made especially vulnerable.

It has been shown that a wide variety of memories can be falsely created, either inside or outside of a therapist's office, through the use of suggestion, guided imagery, and hypnosis. Though these techniques do not always result in false memories, experiments suggest that a significant proportion of people will believe in and actively defend the existence of fabricated events, even after they are told that the events were false and deliberately implanted (Reyna & Lloyd, 1997). False memories involving childhood sexual abuse have gained significant attention because, even when it is clear the accused is innocent, the accuser can be irrationally convinced to the contrary (Loftus & Ketcham, 1994). Not just the victims of guided imagery believe in its efficacy. Surveys indicate that most Americans believe psychologists or hypnotherapists can free

up traumatic events that were previously inaccessible or repressed, even though research does not support this (Loftus & Loftus, 1980). False memories can even be created by suggestions that are much more subtle.

Eyewitness testimonies, for instance, were thought to be highly reliable at one time until cognitive psychologists were able to show that the memories that these testimonies rely on are highly volatile and heavily vulnerable to contaminating information. It is worth mentioning that false testimony is thought to be a common occurrence despite the fact that the witness, who is under oath, often believes resolutely in their testament (Loftus & Loftus, 1980). It is becoming clear that our conscious mind can come to believe things that are patently false because its reality constructing mechanisms often act in prefabricated and obstinate ways. Inflexibility in our memory and thought has been shown to affect our ability to understand even our own intentions.

Neuroscientist Michael Gazzaniga (1998) has a paradigm that explicates why we are so susceptible to mistaken thought and how it is intimately tied to the way the conscious mind pieces the world together. Gazzaniga formulated this paradigm after working with split-brain patients with callosotomies. These patients have had their corpus callosum cut in half (sagitally), effectively isolating the left and right hemispheres from each other. Gazzaniga observed the speechless, right hemispheres of these patients command the left half of the body in ways that were inconsistent with the wishes of the speaking, left hemisphere. One might expect that the left hemisphere would report that it could not explain these actions and that it was not responsible for them. However, Gazzaniga (1998) found that often the person would confabulate; they would make up

false reasons for why the right hemisphere did what it did as if they had been in control all along. It was disconcertingly clear that otherwise sensible people were not at all aware of this conspicuous subterfuge. This led Gazzaniga to posit that much of our immediate behavior must be mediated by unconscious, habitual, or procedural brain systems, and that we often only have the capacity to analyze our decisions after we act on. He purports that what he calls the interpreter, the language center in the left hemisphere, does its best to provide rationale for decisions and actions after the fact, and that this has the potential to result in blustering, duplicitous distortion (Gazzaniga, 1998). Rigorous experimentation on normal people without callosotomies have supported this conclusion, showing that spontaneous cerebral initiative to action, involving no preplanning, precedes conscious awareness of the will to act by more than 300 ms (Libet, 1985).

When we respond quickly to an environmental stimulus, the conscious mind does not have the time to be considerate and reflective. Often we act simply because we trust an intuition. Since subconscious brain modules perform these cursory actions (behaviors that can often seem complex), our conscious mind never has the opportunity to understand what was done or why until afterwards. As it is not involved in the planning of many fast responses (and because much of the cortex does not have direct connections to many subconscious motor areas, such as the basal ganglia), it can only infer from what it can gather through the senses, why the lower areas did what they did. Studies of the neuroscience of free will have shown that a person's brain can commit to certain decisions from a half a second, to several seconds, before the person is consciously

apprised of the decision (Soon, et al., 2008). Some researchers have inferred that, because our conscious selves are updated independent of the unconscious guidance mechanisms, most people may confuse the correlation of conscious experience with movement for causation (Schlinger, 2009). Not only the creation of motor movement but the immediate creation of sensory imagery – thinking itself – may be highly guided by determined by unconscious processing. This impels one to wonder how often our beliefs are predicated on thoughts that are invalid or uninformed attempts at explaining unconscious phenomena. At first glance it appears to trivialize the role of beliefs, as we have said that beliefs are mediated by conscious thought. Upon further inspection we remember that beliefs can become deeply ingrained and that perhaps a large amount of unconscious action can reflect past conscious belief.

When we have the time to think before acting, we often employ preconceived models, or schemata, to help orient ourselves conceptually. Schemas are learned conceptual models that people impose on their experiences to aid them in information processing, decision-making, and memory (Bartlett, 1932). A schema for a certain social situation might contain the sequence of events normally associated with that situation. Our schema for visiting a friend may include calling ahead of time, greeting our friend, interacting with them, and finally thanking them. Examples of schemata include academic scripts, social worldviews, stereotypes, and archetypes. Schemas can help to make certain routines become second nature and help us to develop mental representations or "theories" about how our world operates. Sometimes we use schemas, mental frameworks, for commonly occurring things, to help us organize current

knowledge, and to provide structure for future understanding (Bartlett, 1932). We can utilize our schemas to prod us into remembering events or hard-to-recall facts (Brewer & Treyens, 1981). They help make processing less effortful. For example, I might forget what I wore last Sunday, but remembering that I attended church might help to expedite my information search.

Using schemas incorrectly, however, can easily lead to cognitive errors. The misapplication of a schema is very similar to confabulation. Sometimes one has to think outside the box and consider the possibilities of other less normative routines coming into play in order to avoid these errors. Many people with self-limiting schemas, even those that have demonstrated insight into the questionable origin of the schema, still adhere closely to them, and continue to act on them, even when it would be far easier to abandon or even temporarily ignore them (Hoffer, 2002). Since beliefs constitute habitual ways of perceiving the environment, they are, at least in many ways, comparable to schemas. It seems that like beliefs, the repeated utilization of a schema increases its consolidation and makes it less susceptible to disruption (Hoffer, 2002).

This list of common mistakes of belief formulation includes both conscious oversights and unconscious inadvertences. We search for meaning in the wrong places, connect the dots in the wrong ways, and adopt frames of mind that miss the big picture. The solutions to correcting most of these mistakes appear to be common sense, but so many of us fall prey to them and others like them, on a daily basis. It is clear that once informed, people can make efforts to resist some of these pitfalls (Tversky & Kahneman, 1982). At best, these mistakes can lead to extreme views in matters of opinion, but at

their worst, they can cause people to adopt beliefs that are contrary to what most people know, causing them to be ridiculed, pitied, or at very worst, institutionalized. Interestingly, the delusions of a person with pronounced schizophrenia or drug-induced psychosis appear to be formed under the same conditions as false beliefs.

Chapter 6: False and Delusional Beliefs

"The heart has its reasons of which reason knows nothing."
-Blaise Pascal

It seems that the literature on delusions can be brought to bear informatively on the literature on beliefs and vice versa. There are important differences between delusions and normal false beliefs. Most false beliefs can be challenged, modified or brought to extinction if they prove erroneous or unsupported. Delusions though, persevere even in the absence of support and in the face of strong contradictory evidence. The American Psychiatric Association defines a delusion as a "false belief based upon an incorrect inference about external reality," one "that is firmly sustained despite what almost everyone else believes and despite what constitutes incontrovertible and obvious proof or evidence to the contrary (APA, 1994)."

It is thought that it is possible to describe delusions accurately in terms of associative learning (Miller, 1989). According to this interpretation, in a delusion, one concept is linked somehow with another, but under a fallacious association. Given this, the concept of extinction, the uncoupling of two formerly associated things, may be an appropriate construct to represent the resolution of a delusion (Miller, 1989). If a delusion is resolved, the explanatory, causal associations that held the delusion together are disentangled so that the concepts are no longer coactivated together. This is thought to be similar to the decline of a salivary response to a bell that was formerly, but no longer, paired with food. During associative learning, also known as conditioning, an organism

learns to associate a previously neutral stimulus (such as a tone, referred to as the conditioned stimulus) to a reinforcer (such as food or an electric shock, referred to as the unconditioned stimulus). Once a dog is exposed to the ringing of a bell several times without being given food it learns not to expect the food in this new situation (Pavlov, 1927). At first it associates the absence of food with some new (misleading) contextual cues that allow it to differentiate between the original situation where the bell predicted food, and the new association. Eventually though, with enough pairings, the dog learns that the bell is not associated with food and the extinction of this association is thought to involve an inhibitory mechanism that overrides the midbrain dopamine neurons responsible for maintaining the strength of the original association (Pan et al., 2008).

It is thought that in schizophrenia (a disorder marked by dopamine dysregulation); individuals are relatively insensitive to this type of extinction. They do not learn to inhibit the previously reinforced response. Delusions, however, do more than persist in the absence of confirming evidence; they also persist in the face of contradictory evidence (Rubin, 1976). When faced with clear, counterfactual indications against their delusions, the deluded often confabulate, make further erroneous suppositions or preposterously transform disconfirming information into confirming information (Joseph, 1986).

Attempting to question the delusion of a deluded person is often futile. Simply brining up their delusion activates it, strengthens it and makes it more available in the future. This process is called reconsolidation and it makes it so that the two concepts being associated are more likely to be coactivated again in the future. In the same way that beliefs can be weakened by extinction, they can be strengthened by reconsolidation

(Eichenbaum & Bodkin, 2000). Depending on how the memory for a belief is reactivated, it may be opened up to condemnation or simply made highly salient so that it is highly associable and reconsolidated. Just being reactivated may make the memory traces responsible for the false belief more stable and more likely to be activated by related memories in the future. Hence, the salience of reactivation may matter more than whether it was confirmatory or disconfirmatory in fixing the belief. Salience probably plays a large role in determining which memory traces are reconsolidated into knowledge and in turn, are enshrined as beliefs.

As the deranged, confirming memories become less available and the delusion becomes weakened and less salient, the deluded person experiences ambivalence between belief and disbelief. Such double-bookkeeping occurs when a delusion persists but the person does not act on it consistently (Sass, 2004). When psychotic individuals go on antipsychotic medication, the memory trace mediating belief in the delusion is not erased completely; it is merely overshadowed by extinction learning. This explains why delusions often return once medication is ceased (Chadwick, 2001). It has also been shown that confronting deluded patients with reasons for why their delusion is unrealistic often actually strengthens the delusional belief not only because of reconsolidation but sometimes because the patient is so inflexible that they incorporate the inconsistent information into their delusional schema (Milton et al., 1978).

In the discussion of delusions and extreme false beliefs, two very important concepts come into play: motivational salience and prediction error. Motivational salience is a quality of objects or events that affects a person's interest in them and affects

the person's relevant actions. Salient stimuli command attention and direct goal-driven behavior (Berridge & Robinson, 1998). People who are delusional often have a skewed sense of what is salient and might become motivated by superficial or misleadingly important things. This may be continuous with the "utilization behavior" seen in bilateral frontal lobe damage, where a patient's behavior is obligatorily linked to the most obvious "affordances" presented by the objects in their immediate environment. When the frontal damage is extensive, the patient may display the "environmental dependency syndrome" where they have no capacity to inhibit pre-potent motor programs that are procedurally linked to the presence of certain objects (Lhermitte, 1986). A delusional person with skewed motivational salience does more processing between input and output but has limited capacity to inhibit pre-potent salience programs. A distorted sense of importance causes them to attend to minor, emotionally laden stimuli at the expense of the bigger picture. It causes them to act on these impulses but, unlike environmental dependency, they have enough cognitive reserve to actually analyze and formulate beliefs about them. These beliefs are usually simplistic and often paranoid. The beliefs themselves are likely to be faulty. The emotionally salient aspects of the situation overpower other, often more causal, considerations and they contaminate subsequent conclusions.

The second valuable concept in delusory thinking, prediction error, represents the mismatch between what we expect to experience in a given situation and what we actually encounter. Prediction error has been shown to be a fundamental parameter in associative learning models, and it often determines the strength of perceived salience (Smith et al., 2006). Only a limited subset of factors is considered making the prediction

inaccurate. Efforts that are made to reduce this mismatch result in a clearer and more accurate worldview. It is thought that prediction errors and salience are interrelated, and together, greatly affect the formation of delusions seen in individuals with schizophrenia (Murray et al., 2008). To someone with psychosis, events that are insignificant and merely coincidental can be perceived as significant, can command attention and, after analysis, can seem to relate to each other in meaningful ways. Clearly, both false beliefs and delusions have mistaken or meretricious associations at their crux.

A person does not have to be delusional to be deluded about certain statements. Studies have shown that, when asked, most people indicate that they believe that low self-esteem is a cause of aggression, that crime in America is steadily increasing and that cosmetic implants cause major disease. They believe these things even though research indicates that these are all false and it is highly unlikely that the respondents had ever been exposed to good evidence for them (Kida, 2006). But false beliefs are not all bad. Perhaps, under certain circumstances, it can be harmless, or even beneficial to formulate a false belief or two. The best way to test a hypothesis is to take it seriously for a while. Humans learn through the process of trial and error and erring sometimes allows the learning of important life lessons and demonstrates how and why certain strategies are not preferable.

Normal people are more likely to accept a false belief if other have accepted it. Collective false beliefs, often called mass delusions, have been documented several times in the United States in only the last 50 years. In the spring of 1954, tens of thousands of people were convinced that a windshield-pitting epidemic had broken out. All scientific

investigations of this phenomena reported that no increased window pitting had occurred at all and that because of simple suggestion- the salience changed- people were looking at their windshield, searching for pits, instead of what they usually do, looking through them (Medalia & Larsen, 1958). Historically, Homo sapiens have convinced each other (despite good, available evidence to the contrary) in animal spirits, astrology, ghosts, psychic powers, witches and demons. Even today, superstition, religious mythology and magical thinking play a large role in our culture and in many peoples' everyday life.

Chadwick and Lowe (1994) reported that four main principles have emerged from the application of cognitive therapy toward delusion: a) Belief modification should begin with the least strongly held beliefs; b) Patients should be encouraged to consider the alternative to the delusional belief rather than encouraged to try to accept the alternative immediately; c) Evidence for the belief should be challenged before the belief itself; and d) The patient should be encouraged to voice the arguments against the belief his or herself. These principles demonstrate that treatment of delusion is a tender and touchy matter that many patients exhibit high levels of reactance against. These also show that it is important to try to undermine the foundation of the beliefs before attempting to topple it directly. It can be extremely difficult to alter beliefs even in non-delusional people. Some questionnaire work done measuring plasticity in occupational-related beliefs concluded that most beliefs could not be changed in the short time span of a few hours (Harris & Daniels, 2005). It seems that the dopaminergic pressure reinforcing the associations between concepts, even in non-patients, can be very difficult to overcome.

Uncovering the neuroscience of belief should help to elucidate causes and treatments for false belief but should also tell us much more.

Chapter 7: The Neuroscience of Belief

"One must marry one's feelings to one's beliefs and ideas. That is the only way to achieve a measure of harmony in one's life."
-Napoleon Hill

Beliefs form and change in the brain. However, not much has been said about where beliefs reside in the brain, what brain processes are responsible for them or what changes in the brain when beliefs change. That almost no literature addresses this topic forces the present author to offer speculation about the neural underpinnings of belief.

First we must consider the important question of whether different beliefs can be said to share neurological characteristics. Clearly, no two beliefs are the same, and thus, the brain basis for any two beliefs must be different. Recognizing that there are many kinds of beliefs makes it clear that it is a difficult task to attempt to use the reductive method to pinpoint where and how beliefs form in the brain. Many singular concepts can be reduced to their component parts in the way that our brain can be reduced to individual cells or the way cells can be reduced to molecules. Not all concepts have to be singular to be broken down to their constituent parts though. Scientists have been keen on explicating molecular and neuroscientific reductionist accounts of memories, which, like beliefs, consistently differ from one another in many ways. These individual differences have not stopped memory researchers from dissecting and classifying memories on neurological grounds and likewise, should not impede our progress. Indeed, from a neuroscientific perspective, belief and memory overlap substantially with each other, it is just not yet entirely clear how.

Memories are recorded in the brain as alterations that modify the firing patterns between neurons. These modifications are mediated by either physical or chemical changes in cellular structures. One of the most plastic components of the neuron is the synapse which takes advantage of protein synthesis either to increase or decrease the sensitivity of the postsynaptic neuron to the presynaptic neuron (Kandel et al., 2000). Small networks of neurons that "fire together" to create representations of things in the environment, become "wired together." After they are "wired up" they comprise a stable representation of some feature in the environment that can be activated to contribute to a sensory perception or to mental imagery. The smallest and most localized of these networks code for the most basic stimulus features and are commonly called neural assemblies (Kandel et al., 2000). When a number of features held by different assemblies are coactivated, they bind together to create representations of objects and concepts (Baars & Gage, 2007). Most memories involve coactivations across large numbers of these neural assemblies; building features into complex structures. The more the assemblies responsible for a memory are coactivated together, the more entrenched the memory becomes and the stronger the affinity between the coactivated assemblies. Beliefs, like memories, must be composed of neural networks and their constituent assemblies.

Conscious, associative memories and the networks responsible for them, are commonly thought to be etched into the synapses of neurons of the cerebral cortex (Thompson, 2005). The cortex is a wrinkled sheet of neural tissue covering the brain that (because of the distribution and plasticity of its synapses) exhibits a more profound

capability for learning than any other area. The connections that form outside of the cortex, in subcortical areas of the brain, are responsible for automatic and reflexive behaviors (and even perhaps for behaviors that reflect ingrained beliefs) but probably belief formation or change. Activity in the cortex, especially in frontal and parietal fields is responsible for conscious thought- the kind of thought necessary for belief dynamism. At first, like all new memories, freshly generated beliefs are stored in the hippocampus along with other contextual elements that surrounded the belief at its inception (Baars & Gage, 2007). As the information is gradually transferred from the hippocampus to other cortical areas it becomes separated from its episodic context making it difficult to recall how and when it was first learned (Smith & Mizumori, 2006). This phenomenon, called source amnesia, probably contributes to the difficulty in recalling whether memorable information had factual merit (Schacter et al., 1984). Again limitations inherent in human memory retrieval impact the accuracy of beliefs. But, in much the same way that beliefs are more than knowledge, they are also more than just activated memories.

Beliefs are memories that have associative meaning relative to other memories. This associative or propositional meaning allows them their utility, their applicability in problem solving, self-directed action and day-to-day life. The prefrontal cortex (PFC), the "central executive" of the cortex, probably contributes heavily to our ability to piece together simple memories to create beliefs (Kandel et al., 2000). The PFC sits above and in front of the other brain areas and fine tunes our actions by inhibiting, overriding and commanding posterior-cortical, subcortical and spinal areas to modify their tendencies and reflexes (Sylvester, 1993). The PFC has this ability because it is wired up to receive

fully processed information from a large number of different areas giving it the perspective to make multimodal, cross-conceptual associations. It also has the ability to inhibit these other areas, allowing it to replace impulsive responses with better informed responses and to orchestrate the efforts of separate brain modules. The cerebral cortex, guided by the PFC, is probably the only part of the brain that has an overt capacity for logic and the weighing of evidence but as we have seen, the thoughts and behaviors that it directs are often approximations that may result in faulty beliefs. Conversely, reflexive, subcortical areas, such as the brain stem, the midbrain, the basal ganglia and the cerebellum operate outside of consciousness yet still, they can administrate behaviors and decisions that are functional and that can appear logical (Baars & Gage, 2007). For example, in most animals the cortex is proportionally very small relative to these subcortical areas, yet animal behavior is highly functional and purposeful (Alcock, 2001). Does this mean that animals are guided by instinct and implicit learning but not belief? It can be difficult, especially in animals that cannot report on their experiences, to determine whether the response to a stimulus is mediated by conscious or unconscious brain activity. The association responsible for the salivation response shown by Pavlov's dogs is contingent on an association in the brain; however, it is not easy to determine if this association is an unconscious, automatic reflex (Moscovitch et al., 2007). If the dog salivates after it hears a bell, and it has no access as to why, the response would be indicative of an associative memory in the animal's subcortex without a corresponding belief. A conscious, propositional association between the bell and the provisioning of food could mediate the response though, in which case, it would constitute a belief. The

response could also be both reflexive and conscious depending on the given animal's mental state.

If the response exhibited by a Pavlovian dog is only mediated by a subcortical reflex then it does not constitute a belief. But, if the response involves cortical processing it may constitute a belief. Especially if the dog is intelligent enough to become aware of the association and to use memories of it to inform other behaviors, then perhaps it should be seen as a true belief.

As we pointed out earlier, many human beliefs probably start unconsciously as gut feelings, acquired through classical or operant conditioning, that we later came to be conscious of. Like other animals, through trial and error, reward and punishment, we are conditioned by our environment to have certain tendencies. If we can become aware of these tendencies (associate the association to other associations), they are no longer simply behavioristic and can be called true beliefs. Once a belief becomes highly associated to other memories, it is reconsolidated, made salient and potentiated for use in guiding behavior. Like the simplest of animals, humans have tendencies that they never become aware of. The difference between a human and most invertebrates though is that humans can become aware of most of their tendencies because their attention can be directed to the high-level abstractions necessary for introspection.

Animals, which have sense organs to receive stimuli and muscles to react to them, are continuously bombarded by sensory stimuli from their environment. Overtime, guided by reflexes, instincts, innate behavioral tendencies and prepared learning, they develop complex ways of interpreting the perceptions that stream through their senses.

Some coopt this process, drawing conclusions about experiences to form subjective knowledge (Greenough, et al., 1987). This process uses knowledge to build knowledge. New learning interacts with, and is perceived in terms of, old learning as no belief ever appears in isolation. Swiss psychologist Jean Piaget (1977) viewed learning in terms of two basic processes: assimilation and accommodation. He defined assimilation as the process whereby an individual interprets their environment in terms of their own internalized model of the world that they have been forming since their creation. Accommodation is the process of changing the internalized model to accommodate the new information. These two processes were intended to be applied to knowledge but can also be applied to belief. Beliefs involve a good deal of assimilation and accommodation-mental work that requires working memory, active representation and modeling, comparison of alternative scenarios and conscious, cortical deliberation.

How much consciousness, or alternatively, how much cortex do you need in order to have the processing power to truly believe things? There is very little research on belief in animals, although it is assumed that most animals are relatively limited in what they can believe but that humans, with large brains and language, are fully equipped to acquire and personally manufacture beliefs about virtually anything (Damasio, 2000). It seems clear that many vertebrates, especially mammals, are rational agents that can be understood not only from a behaviorist but also from a cognitivist perspective (Dennet, 1991).

Daniel Dennett (1998) has affirmed that many species of animals can hold beliefs-especially if one is using a liberal definition of belief. The capacity to entertain explicit

beliefs and to evaluate and reflect on them though, is probably a recently evolved innovation, rare or absent in other species. Humans alone embellish beliefs using language. Beliefs held by intelligent animals, although not implicit, are less explicit than those of humans because animals associate their beliefs to a much smaller number of concepts. For instance, an animal may recognize a belief - knowing that it used this belief in the past - but may not be equipped with the right conceptualizations or vocabulary to know how to doubt or question their belief. It has been made clear that humans have can also have trouble questioning beliefs but humans are shown informally by others about how to believe – lessons animals rarely have.

At the outset of this section, we asked three questions about beliefs that we still have not answered sufficiently. Beliefs probably reside, like memories, within networks of neurons and (in a psychological sense) within the mental imagery that these networks create. The cortex, especially the PFC and Wernicke's and Broca's language areas, are probably responsible for the human ability to manipulate, question and be aware of beliefs. Belief change probably involves the dissociation of shared activity between the networks responsible for two previously associated memories. We have seen that this dissociation is made more easily if the midbrain dopamine neurons, that tie the association in with biological drives, release the associated networks from each other. Clearly, these answers are of limited practical use. Allow me to share a personal anecdote that may help shed light on these issues.

Recently I heard a rustle in the top of a tree followed by loud chirping that continued for a number of seconds. A large leaf fell from the tree, but for at least a full

two seconds I mistook the large leaf for the bird that was making the chirping sound. I didn't have my glasses on and I did not realize that the leaf was not the bird until I noticed that it was falling in a way that was very characteristically, stereotypically leaf-like. But for hundreds of milliseconds I "believed" that I was seeing the bird despite the fact that the real bird was totally obscured by foliage the entire time.

It became apparent to me that this illusion was caused by an error in perceptual binding. The neural networks responsible for two different constructs, in two different sensory modalities, were activated. Then these two perceptions were bound together, in the jargon of "operational architectonics," they were integrated in synchronous oscillatory processing. Because they were visually striking and loud enough, the sight and sound gained privileged access to the cortex after being judged for relevance by the thalamus. At first, these stimuli were processed for content at the level of primary sensory cortex: primary visual (striate) cortex for the sight of the leaf and primary auditory cortex for the sound of the bird. Here, their spatial and temporal frequencies were given the chance to excite existing neural networks in order to determine if their features mapped on to anything I had experienced before. This message was passed from the primary sensory areas to secondary sensory areas, where they excited assemblies that corresponded to their unique traits, allowing more detailed identification of structure and form. Then the messages traveled from the secondary sensory areas to higher order, more globally communicative areas.

The information was allowed to spill into the brain regions responsible for processing experiences outside of a single modality like the prefrontal, occipitotemporal

and intraparietal cortex. These “association” or “convergence” areas, which are equipped with the right inputs to consider multisensory information, have networks that are able to accommodate the binding of visual with auditory stimuli. According to the neural binding hypothesis, brain areas with different neuronal assemblies fired in synchrony to unite different features of these neuronal representations together. In my opinion, these higher-order interpretations are sent back to the earlier (primary and secondary) sensory processing areas just mentioned, creating visual imagery that corresponds to the interpretations of the association areas. In other words, bottom-up mental imagery evoked by a top-down interpretation, of a bottom-up perception caused a picture of a bird in my mind’s eye to be superimposed over the falling leaf.

I heard chirping, saw a large leaf begin to fall and failed to question whether the two stimuli might represent different entities. This perception was automatic in the sense that my brain fused the two stimuli before I could question the association consciously. After I had the time to do so (it takes tens of milliseconds for the frontal lobe to have access to the output of the sensory areas), I still did not change my immediate perception and found myself consciously expecting to see the leaf fly away. It probably was not until motion neurons, located in visual area 5, identified a familiar pattern in the motion of the leaf that I became aware that a bird would never fall as slowly and as waveringly as a leaf. This mistake in binding, a common occurrence underlying everyday mistakes, is sometimes called an illusory conjunction. It is clear that I fully believed that this leaf was a bird, and this was due to binding between stimuli that should not have been bound. This association took place automatically and had to be questioned deliberately in order to be

fixed (or perhaps it was superseded by the subsequent automatic perception of the leaf's motion).

This example can be thought of as a bottom-up belief. Incongruous sensory elements were fused or bound before higher-order areas could intercede. This can probably take place with emotional learning (such as conditioned fear) and procedural learning (such as the salivation reflex). Binding can also be controlled by higher-order association areas and the resultant associations could be thought of as top-down beliefs.

It seems rational to assume that many false beliefs occur because the wrong concepts are bound in association areas where different features can converge into one. Such perceptual illusions are rare because people become experts at perceiving physical events without error from an early age. Higher-order perceptions and representations though, ones that are not seen but imagined, are probably much more fallible. Such cognitive perceptions consist of judgments involving many moving parts and can be extremely difficult to parse apart, collect evidence for and question systematically. These perceptions, held in association areas, involve concepts like existence, import and relative efficacy, whereas the lower-order perceptions, held in sensory areas, involve things like contour, color and timbre. Higher-order beliefs probably work much like sensory ones, and go wrong for the same reasons. Both involve perceptual elements, that, after limited information is considered are bound together to create a new, higher-order perceptions. Sometimes, like a superstitious belief, these are chimerical contrivances that have no basis in the real world. Once the binding of memories that should never have been bound happens, mental imagery corresponding to the conjunction is created. Once this imagery

is analyzed and acted upon a few times, aspects of it become implicit, making it difficult to regain conscious insight into the reason for the underlying belief. Happily, with experience and concerted practice, we become accurate and proficient in the way that we conjoin higher-order concepts.

Chapter 8: Ontology of Belief

"For those who believe, no proof is necessary. For those who don't believe, no proof is possible."
-Stuart Chase

The objective existence of belief and similarly indefinite concepts in psychology has been questioned. Ontology, the philosophical study of being, involves determining what things can be said to exist in reality and what kinds of existence there are. Some philosophers, most notably of the Platonic school, contend that to exist, something must be referred to, or referable to, by a noun. In fact, according to some, all abstract nouns are thought to refer to existent entities (Griswold, 2001). Beliefs then, by this criterion, do exist. Other philosophers contend that nouns do not always refer to entities but that they often refer to collections of entities or events that do not necessarily sum to an objectively existent whole. Thus, beliefs may not be real, only nominal.

There do not seem to be any established methods of determining the existence of many non-physical entities such as beliefs, minds, communities, thoughts or happiness. Beliefs certainly cannot be easily scrutinized or manipulated as concrete, physical objects can. That a belief can be "held" but not touched tells us that we can bring some schemas to bear on beliefs but that many schemas fail to be compatible with them. When some schemas work with an abstract noun, it implicitly appears to be real. Beliefs may be defensible in some instances, but if it is indefensible in most, if it is incompatible with most scientific schemas, can it really be said to exist? Habitual, unobserved use of the word belief probably makes people implicitly assume that they are as real as any physical

object. This reveals that beliefs can be conceived as patchwork of explanations and abstractions that has a place in lay discourse but very limited scientific utility. One could even go so far as to say that many common concepts such as the self, love, attitude, consciousness, the soul and beliefs can be seen as inadequately specified, indefensible fictions.

Many in this area of research contend that if belief is a defensible, adequately specified psychological construct then it should be possible to identify the underlying neural processes that support it (Baker, 1989). However, if beliefs are not equivalent to mental states, are incoherent or ultimately indefensible, then any attempt to identify their underlying neural substrates will fail. Much of the contemporary literature on beliefs in philosophy has been devoted to the validity of the term belief as a natural or neuroscientific phenomenon.

Jerry Fodor published well-received work supporting the notion that the most people's common-sense understanding of belief is correct (1985). This is sometimes called the "mental sentence theory," which perceives beliefs as simple statements and purports that the way that people talk about beliefs in everyday life is more or less complete and scientifically valid (Baker, 1989). Three twists on this conception exist. Stephen Stich argued that our common-sense understanding of belief might not be entirely correct but that it is useful until we can devise a more scientifically accurate understanding. Paul and Patricia Churchland advocate a view called eliminativism, or eliminative materialism, which argues that the common-sense understanding of beliefs is not scientifically accurate and will eventually be replaced by a different and

neuroscientifically accurate account. These philosophers of mind argue that no coherent neural basis will be found for many everyday psychological concepts such as belief, desire, or even thought. Daniel Dennet (1998) and Lynne Rudder Baker (1989) take the third position on the common-sense understanding of beliefs, in what Dennett has called the "intentional stance." Dennet says that our current conceptualization of what beliefs are is entirely wrong but that it does have some redeeming value such as its utility in generating testable hypotheses about intent, motivation and logic. It may never be completely clear, even with definitive and comprehensive knowledge of neuroscience, whether and when belief is an ontologically valid construct. Beliefs, like consciousness carry crucial subjective aspects that science may never be able to capture or explicate. Certainly, however, the term, belief, is functional and instructive for learners, children especially. Imagine growing up without the concept of belief. During early cognitive development the concept of belief is instrumental in the creation of mental models concerning empathy, decision and knowledge acquisition. Even beliefs flout ontology, at least they facilitate ontogeny.

Chapter 9: The Neuroscience of Thought

"Believe none of what you hear, and half of what you see."
-Benjamin Franklin

Introduction

This article presents an analogy meant to integrate known information into a theoretical interpretation of the neurocognitive events that underlie transitions between mammalian brain states. Gradual changes in a pool of simultaneously coactivated neurons occur as cortical assemblies that continue to receive sufficient activation energy are maintained, assemblies that receive reduced energy are released from activation, and new assemblies that are tuned so as to receive sufficient energy from the current constellation of coactivates are converged upon, recruited and incorporated into the remaining pool of active assemblies from the previous cycle. This neurophysiological process is presented here as analogous to the locomotive behavior of a many-armed octopus that grabs and releases footholds as it pulls itself from place to place.
The stride of an octopus that plants the majority of its arms temporarily while actively repositioning arms that have let go of their footholds, represents the uninterrupted, nonlinear, spatio-temporal pattern of assembly activation, deactivation and coactivation in the brain. This analogy uniquely describes a system where certain nodes are conserved through time as others come and go.

The fact that some assemblies within association areas remain active for prolonged periods (i.e. the octopus arms remain planted), during reciprocal top-down to

bottom-up communications, is taken to account for the continuity found between successive brain states. The longer assemblies in association areas can be continuously activated - over a series of states - the longer they can influence sequences of bottom-up imagery in a sustained and consistent way allowing modeling, planning and working memory in general. The result is a stream of consciousness where each thought is quantitatively different from the ones preceding, as newly relevant assemblies are added and the least relevant ones are removed. Highly intelligent mammals have a larger group of available assemblies to select from, can coactivate a larger number of assemblies together simultaneously and have the capacity to prolong activation in goal-relevant association assemblies for extended periods. Prolonged activation of association assemblies (made possible by the tonic firing of prefrontal and parietal neurons) allows the topological imagery created in early sensory areas to reflect, not only the bottom-up inputs from the immediate present, but also top-down inputs from the recent past. In the most highly intelligent animals motor output (decisions) and early sensory activity (imagery) reflects several seconds worth of overlapping association activity.

Relevant Literature

Some of the important questions in cognitive neuroscience today include: 1) How can the thought process, the sensations of consciousness and the functionality of working memory be described in terms of brain events? 2) How do elemental features (fragments) of long-term memory combine together to represent entities and episodes? 3) What neurological events take place when mammals transition from brain state to brain state or thought to thought? 4) What is the nature of communication between association and

sensory areas? 5) How does the human brain permit such sophisticated working memory relative to other animals? 6) What processes in the brain gives rise to the mental continuity that humans experience? Without being able to tie together all of the neurological, psychological and philosophical loose ends necessary to answer these questions comprehensively, this paper will attempt to address them using novel approaches based on a simple analogy.

There are currently many illustrative and biologically plausible theories that address the issues listed above. Some do a fine job of tying together a large number of relevant phenomena into a cohesive picture. Models such as Baar's global workspace theory (Baars, 1997; 2002), Baddeley's theory of working memory (Baddeley, 2000; 2007), Damasio's convergence-divergence paradigm (Damasio, 1989; Meyer &Damasio, 2009), Edelman's theories of reentrance and neural Darwinism (Edelman, 1987; 2006), Edelman and Tononi's conceptualization of a"functional cluster" or "dynamic core" (2001), Tononi's conception of integration of information (Tononi, 2004), and Grossberg and Carpenter's adaptive resonance theory (Carpenter and Grossberg, 2003) have done much to lend perspective and insight into the mechanics of perception, attention, working memory and consciousness. Despite much progress, most scientists report that current theory is unsatisfying because it cannot yet bridge the gaps between epiphenomenal consciousness, brain processes and neural connectionism (Chalmers, 1995; Chalmers, 2010; Shear, 1997). Further, even though many contemporary models largely agree with empirical data, little has been done to reconcile their disparate approaches (Pereira & Ricke, 2009; Vimal, 2009).

This work presents an analogy that intends to integrate current knowledge about neurocognition, while remaining consistent with other theory in the literature. It approaches the questions posed above from what is perhaps a much neglected perspective, that of the biological basis for transition between brain states. An analogy involving the ambulatory behavior of an octopus is offered here to provide perspective. The octopus holds localized assemblies of active cortical neurons in its arms and its pattern of locomotion is taken to resemble the pattern of cortical activation and deactivation. The analogy will grow to encompass several phenomena related to cognitive neuroscience and will eventually inform a theoretical interpretation of the generation and subsequent embellishment of mental representations as they pass between sensory and association areas. Simple, localized assemblies of cortical neurons are taken to be the building blocks of these representations and the cornerstone of the framework so let us define them first.

Microscopic, Localized Assemblies Hold Fragments of LTM

Like several other models of mind-brain processes, this model views cognition as a system responsible for using representations in long-term memory (LTM) to guide goal-directed processing (Moscovich, 1992). The present model is consistent with connectionism and parallel distributed processing in that it conceptualizes mental representations as being built from decentralized, interconnected networks of nodes that have multiple inputs and outputs (Gurney, 2009). Like other biological models, it envisions these nodes as modular neural units in the cerebral cortex and assumes that each individual unit represents an elementary feature or fragment of LTM (Meyer &

Damasio, 2009). To construct a higher-order LTM-based representation, the cortex must combine a subset of the numerous units at its disposal (which each represent stable, preexisting microrepresentations) into an improvised composite representation. Importantly, representations are constrained to being built from preexisting units and the brain does not attempt to represent what it experiences in the environment using anything but combinations of these "receptive field units." Thus working memory, thought and consciousness consist of the activation and intricate copresentation of fragments of long term memories.

Here this fundamental unit of cognition is taken to be comprised of a number of similarly-tuned neurons that are synaptically bound to create a functionally discrete assembly or "cognitive atom" (Lansner, 2009). Because the neurons of such an assembly share similar (or nearly the same) receptive field, they all respond to a particular conjunction of stimuli and can be said to have a unique although primitive "window on the world." A single assembly then, has an aspect of irreducibility in the sense that its constituent neurons often fire together when they fire maximally. These assemblies are capable of being activated and spreading their activation energy to assemblies that they have been associated with in a Hebbian fashion. An assembly is activated by the simultaneous firing of multiple other assemblies that have come to be associated with it. Thus the assemblies, like the neurons that compose them, function as coincidence detectors (Fujji et al., 1998).

These assemblies mostly probably closely correspond to cortical minicolumns of cells. This is so because minicolumns consist of neurons with highly similar receptive

fields that are thought to map onto a specific, elementary, perceptual feature (or fragment of such a feature). Exactly how these discrete fields of cells function and interact has been relatively mysterious since the columnar organization of the cerebral cortex was first delineated by Vernon Mountcastle (1978). This article will continue to refer to the previously described "receptive field units" (meant to represent a mental building block) as assemblies, however, it is meant to be implied that the cortical minicolumn is a likely candidate for this construct despite some reservations regarding its internal consistency and presumed unitary nature. Importantly, minicolumns contain microscopic and conceptual structural inconsistencies making their boundaries fuzzy in numerous respects. However, minicolumns are somewhat spatially distinct, contain neurons with highly qualitatively similar receptive fields and contain the necessary communicative properties as they span each of the cortical layers. Neurons are not equally good candidates for a "receptive field unit" (cognitive atom) because, despite the fact that each neuron has a distinct and singular receptive field, their functional properties vary widely depending on their cell type and the layer in which they are found. Hypercolumns are also not good candidates as they can be subdivided into units with various, qualitatively different, receptive fields. Given that assemblies are equated with minicolumns here, we can think of each assembly as having its own subcortical and cortical inputs and outputs.

Unlike subcortical areas, strictly one-to-one, linear activation is probably rare in the cortex. Also, unlike subcortical areas, information processing in the cortex is not compartmentalized into individual nuclei that are relatively isolated from processing occurring elsewhere. A given assembly will affect other assemblies that are nearby but

will also readily pass activation energy via axonal projections to distant assemblies depending on the combination of early axonal migration and experientially determined connectivity. Cortical assemblies work together by spreading the activation energy necessary to recruit, or converge upon, the next set of assemblies that will be coactivated with the remaining assemblies from the previous cycle. An assembly is released from coactivation when it no longer receives sufficient activation energy from its inputs i.e. its relevance to the processing demands diminishes. An assembly may also be released from coactivation if a number of inhibitory neurons converge on it. This pooling of activity could be referred to as multiassociativity. To differentiate from the established multiassociative neural networks we can abandon the prefix "multi" and call this brand of associativity among neurons, polyassociative.

Figure 1: Polyassociativity Explained

Gradual additions to and subtractions from a pool of simultaneously coactivated neurons occur as:

1. assemblies that continue to receive sufficient activation energy are maintained over subsequent points in time
2. assemblies that receive sufficiently reduced energy are released from activation
3. new assemblies, that are tuned so as to receive sufficient energy from the current constellation of coactivates, are converged upon, recruited and incorporated into the remaining pool of active assemblies from the previous cycle.

Outlining the process of polyassociativity in this way is meant to show that "computation" in the brain is primarily directed at determining which neurons (or assemblies) should be activated next. Polyassociativity describes how spreading activation selects neurons. At one point, it felt to me that psychological concepts are related to one another causally through one relationship or another, but how neurons could record these relationships seemed infathomable. The concept of polyassociativity purports that all of the psychological complexity can be reduced to a simple process. The important concept here that has not been emphasized adequately in other research is that the next assembly or cognitive unit that will become active is actually selected by not one but several coactive assemblies. In other words, nothing becomes active that is not converged upon from multiple directions. This may be the secret, unconscious algorithm of the brain that is difficult to infer from psychology or neuroscience alone. We do not willfully choose our next thought, the components of our next thought are selected by the cooperative firing efforts of the components of the previous thought. WM can be thought of as the active portion of LTM but clearly it performs some kind of work in sensory gating, maintaining information, updating information, sense making, and goal direction. In this author's view, this work is accomplished via polyassociativity.

This process and the way it is outlined is highly derivative of known neuroscientific processes. The way it is presented here should have some value though. It is meant to communicate that processing in the cortex is not compartmentalized, and that most processing trajectories do not lead up to dead ends due to the fact that the assemblies of the cortex are massively interconnected. It is also meant to illustrate that at

any one time there are a complement of simultaneously active neurons that can be split into three groups, those that are newly activated, those that are being deactivated and those that have been active over a succession of time intervals. Clearly, the longer the interval of time between two moments, the fewer the number of assemblies that have been reactivated or conserved. For instance if the distance between moment A and moment B is 10 milliseconds, then a very large proportion of assemblies will be conserved over this period. If the time between A and B is 5 seconds then the proportion of assemblies in moment B that remain from moment A will be much smaller. This concept of neural polyassociativity is taken here to be scalable towards thought in the sense that our next thought will be based on representations that are closely related to the mix of previously active representations. One hallmark of polyassociativity is that the separate assemblies or nodes that are firing may never have all fired together in the past but may uniquely converge upon a new node or set of nodes that are most connected to them. In other words, A,B and C may all activate D, may all have fired with D in the past and may all converge on D in the present despite the fact that A, B and C have never fired together in the past.

It is probably very common that more than two assemblies are each synaptically wired to a common assembly but have never each fired at that common assembly together in the past at the same time. When these assemblies become active their activity will summate to activate the common assembly. In other words, the node most wired with the currently firing nodes will fire next, even if it has never responded to this unique set of activators before.

This model posits that groups of these vertical or columnar cortical assemblies can be bound by coordinated activity to create the neurological instantiations of mental representations. These mental representations are here called ensembles. Ensembles stretch laterally through the cortex and are comprised of assemblies (minicolumns) with disparate but experientially related receptive fields. It is taken that these ensembles span areas of the cortex from early sensory to association areas.

Cortical Assemblies Unite to Create Ensembles Which Are Mental Representations

It is unlikely that individual assemblies represent consciously perceptible constructs. In fact if only one assembly was systematically removed from a complex representation its absence could probably not be distinguished. We will refer to groups of assemblies that represent a whole consciously perceptible construct as an ensemble. This is a highly theoretical proposition but it will allow us to continue in our systematization of neurocognition. The ensemble is a helpful distinction that will lead us to conclude that when a psychologically perceptible construct is displaced from working memory (and the ensemble associated with it loses activation), each of the individual assemblies that constitute the ensemble have a tendency to stop firing as well. Thus there is a many to one correspondence and when a consciously perceptible ensemble is removed from the train of thought, many of its constituent assemblies are often removed as well – unless an assembly has sources of activation independent of the first ensemble (i.e. it belong to more than one active ensemble). In other words, assemblies (which are neural units) can be bound by experience to constitute an ensemble (which is a neuropsychological unit).

Assemblies are bound together in a Hebbian manner due to approximately simultaneous activation during experience.

Assemblies are relatively discrete and immutable whereas ensembles are fuzzy with boundaries that change each time they are activated. The vertical or columnar assemblies correspond to specific, very primitive, conjunctions and are required in great numbers to compose composite representations of complex, real-world objects and concepts. Ensembles are these composite representations and of course have variable, indefinite boundaries as the experience of no two objects or concepts are exactly the same. Assemblies are preexisting, are found in microscopic, fixed locations and are selected as activation energy passes through structurally-descriptive hierarchical networks that function on neural convergence. Ensembles, on the other hand, span these networks (from early sensory to association areas) on a macroscopic scale, are mutable and are inherently improvised. The behavior of an ensemble can be reduced to the behaviors of its constituent assemblies just as the behavior of a population can be reduced to the behavior of people. This is in some ways consistent with Joaquin Fuster's concept of cognits – distributed memories or items of knowledge defined by patterns of connections between neuron populations associated by experience. Fuster emphasizes that his cognits are hierarchically organized, link noncontiguous neurons and overlap and interconnect profusely (Fuster, 2009).

It is known that object recognition involves two-way traffic of signal activity between various neural maps that stretch laterally through the cortex from early sensory areas to late association areas. This activity involves feedforward and reentrant

connections in the corticocortical and thalamocortical systems that bind retinotopic information from early neural maps about the perceived object with higher-order information from later maps forming a somewhat stable constellation of activity (Crick and Koch, 2003) that we conceptualize here as an ensemble. The assemblies that correspond to an ensemble are coactive, presumably are locally synchronous and are bound together through reentrant connections in the corticocortial and thalamocortical system representing constellations of activity that can remain stable for tens or hundreds of milliseconds (Crick and Koch, 2003). Moreover, activity within these ensembles tends to reciprocate on hierarchically structured pathways between cortical sensory areas and cortical associations areas on the order of brain oscillations (Klimesch, Freunberger, Sauseng, 2010). It is important to note that ensembles are not static but are constantly reincarnated and transmuted as additional information is injected into them during the reciprocations between bottom-up and top-down areas. Because of this, delineating the borders of an ensemble is fundamentally arbitrary and subjective.

Feedforward activation from bottom-up sensory areas selects among potential assemblies in association cortex. Conversely, feedback activation from top-down association areas modulates and drives the selection of assemblies in early sensory cortex. Thus, the oscillation of information between abstract association areas and veridical sensory areas allows these two types of cortex to converse, learning from the other's unique brand of content, like two people in a conversation. As stated, the present model addresses aspects of attention, working memory and consciousness but is largely about how neural networks, built of these assemblies, combine their features to create

cycles of mental imagery and thus thought. The octopus analogy will introduce the concept that some of these assemblies are conserved through time and can thus affect imagery for sustained periods bringing continuity to thought. Again, the model proposed will attempt to accomplish two main objectives: 1) offer an analogy between the locomotive behavior of an octopus, and the behavior of neural assemblies; and, 2) offer explanations for how imagery is generated in sensory cortex, subsequently interpreted by association cortex, and then is sent back to sensory cortex, resulting in the creation of updated imagery. After elaborating on the nature of these processes it subsequently attempts to integrate the customary approaches of attention, working memory and consciousness.

The Hypothesis

The nature of the pattern of assembly activation in the cortex is addressed by an analogy, which involves a many-armed octopus grabbing and releasing footholds (ensembles made of cortical assemblies) as it pulls itself from place to place. The analogy captures several neurophysiological phenomena but also fails to capture others. It is meant to illustrate that the thought process involves the simultaneous coactivation of several clusters of cortical assemblies at a time (multiple footholds held by an octopus) as well as the activation of previously inactive assemblies (the placement of an arm on a new foothold) and the deactivation of previously active ones (the removal of an arm from a foothold). This analogy may be valuable because it depicts a system where specific nodes are conserved through time as others are actively repositioned.

In the present analogy, each octopus arm corresponds to an active ensemble, the suction cups on one arm can be taken to correspond to the assemblies that make up the ensemble, and the grains of sand under each suction cup on an arm represent cortical neurons. This analogy is apt because, like the grains of sand on the sea floor, cortical neurons do not move, only the pattern of activation – the octopus and its appendages - moves. The same assembly can contribute its representational content to different ensembles just as ensembles can be combined in different ways to create different thoughts. Neurons, however, may be relatively restricted to the confines of the assembly that they are found within and just how restricted they are may depend on how cohesive individual cortical columns prove to be. For the most part, humans have some ability to guide thought on the level of the selection of ensembles but have almost no control over combinations of assemblies. In other words, humans may have reportable insight into what ensembles they are combining but selection on the level of assemblies is automatic, rigidly biological and perhaps closed to working memory.

When the assemblies of a single ensemble are activated at the same time, the features that they code for are amalgamated into composite mental imagery in whatever way prior probability and previous experience dictate. They sum their component features together to portray mental images and this occurs in both sensory and association areas. How assemblies sum their features to create composite imagery is largely uncharacterized, is related to the binding problem and will be explored here later. When an ensemble is deactivated, the perceptual or conceptual element corresponding to it decays rapidly over time (along with each of its component assemblies) and dissipates

until it no longer impacts present experience. Whatever new ensemble is introduced will inform the present sum of coactivates in a unique and informative way. Thus, imagery changes plastically over time as assemblies that continue to be useful are maintained, assemblies that are rendered less useful are released from activation, and assemblies that are newly recognized as useful are activated and incorporated into the remaining amalgamation of useful coactivations. This is analogous to the "seafloor walking" behavior of an octopus that plants the majority of its arms temporarily and actively repositions arms that lie behind it, toward the front, in the direction of its movement. The fact that the placement of some of its arms are conserved, over sequential moments, gives the octopus balance and stability just as the conservation of some assemblies, during these transitions, provides the physical basis for the continuity of thought. The assemblies that are conserved reside mostly in association areas whereas assemblies in early sensory areas are activated much more transiently. This is as if the arms in back of the octopus (corresponding to posterior sensory cortices) move much more quickly than the forelimbs (which find firm, reliable footholds in anterior association cortices).

The following sections will elaborate on this interchange pointing to the consequences of the octopedal patterning and relating other models to this one. Before this is done, the next section will consider how this octopus analogy was first conceived and how it was revised.

The Old Analogy: An Ape Swinging From Cortical Branches

I have developed and evaluated a few different models for representing the workings of the mind. While doing so I realized that a good model would have to satisfy

certain criteria. The original allegory that I used was of an ape swinging from branch to branch (hand over hand) where each branch represented a group of neural assemblies in the cortex that coded for a new thought. This early analogy tried to convey the idea that the branches, or concepts, from the immediate past determine what branches will be held in the future. It was meant to convey that we move from one thought to the neurologically nearest, most appropriate thought in a deterministic manner. The next chosen branch in the cortical canopy represented to me, the probabilistically most likely association given the person's current thought, given their past and given the structure of their memory. This model of the thinking process is limited because it is linear. I came to understand that localized groups of neural assemblies cannot code for complete thoughts, images, or memories and that assemblies are not activated and then deactivated, one set at a time, in linear sequence. This caricature of memory was limited, vague and failed to capture the polyassociative and unintermitting nature of thought.

Once I started to think nonlinearly, I concluded that mental activities must involve the simultaneous coactivation of numerous assemblies from multiple locations each that code for different features of long-term memories. I since replaced the branch-swinging ape with a walking octopus. I changed the animal because the octopus has more arms and can simultaneously possess more footholds. The many arms introduced important and divergent features to the locomotive behavior that I think creates instructive analogies when superimposed on the neural processes of thought. For example, the octopus analogy has the advantage of demonstrating how several interacting elements combine to allow thought. Also because these elements remain active for different durations, thought does

not stop and go in discrete steps but is continually "carried along" by those elements that endure through time. All elements, or neural assemblies, will deactivate within a few seconds, but the intermingling of assemblies of some temporal stability with those of more fleeting persistence sustains the associative bridges that allow the thematic and unifying consistency that is a hallmark of cognition.

The routine of assembly activation and deactivation is very similar to "polypedal locomotion" or movement in animals with many legs. It is not much like the locomotion of an insect such as a millipede or a centipede though because these animals move their legs in stereotypical, repetitive ways where the placement of each leg is not actively influenced by the placements of other legs or of the qualities of the footholds. The pattern of activations in the brain is more like the polypedal locomotion of an octopus that is "seafloor walking" because it is asymmetrical, dynamic and the placement of the next legs is influenced by the octopus' stance, posture and the characteristics of the footholds themselves. Most importantly, this model can accommodate nonlinear aspects of neurodynamics. One neural assembly does not activate the next in sequence. Several assemblies are coactivated together and they pool their activation energy to determine which assemblies will be activated next.

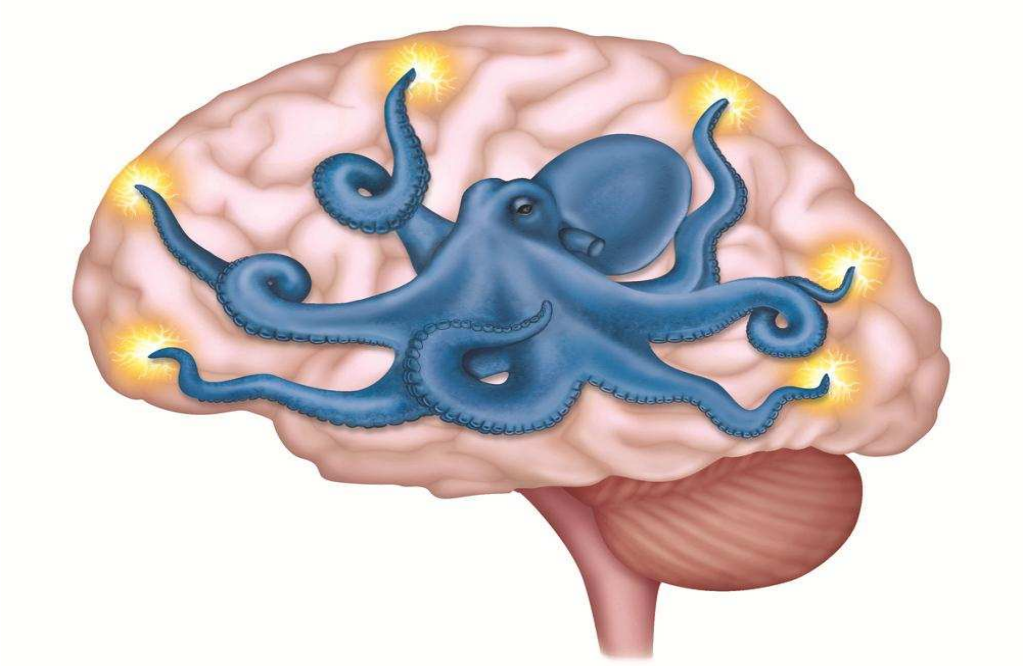
The New Analogy: An Octopus Walking on a Cortical Sea Floor

Individual cortical assemblies fire maximally only when they are converged upon by the neurons present in many others. However, many can be found working together, in concert, at any one time. In the present analogy, the octopus' footholds represent simultaneously activated assemblies. But as thoughts do not hold still, the octopus is

constantly repositioning its arms. The assemblies that are used are constantly cycling as the “octopus” releases some to free up resources (arms) in order to grab new ones.

Even though assemblies are constantly being deactivated, we take many assemblies with us through time. If we did not do this, we could not be informed of what we were just thinking, and we could not have a progressive train of thought. Because some assemblies and their associates can remain active for a number of seconds we are able to transition between closely-related thoughts. Thus, mental continuity has a neural basis. When an assembly receives sufficient activation energy from its inputs it will fire at its targets (its projective field), often firing recurrently at the sources that targeted it (its receptive field), until the configuration of assemblies changes to the point where it no longer receives sufficient activation from either the bottom-up or top-down assemblies that converge on it.

Figure 2: A Depiction of Polyarticulated Neurocognition



Some assemblies can probably be retained even after the transitions between a number of thoughts. This happens when your thoughts cycle and change but hold a common element or theme constant. When we attempt to solve a novel and complex problem we try to keep the majority of our octopus arms firmly planted so that we can keep the problem set in mind. Some aspects of creative thinking or free association, on the other hand, might involve strategically pivoting around a smaller set of continually active assemblies and using these to determine the next set of coactivates.

It is not always the case that the majority of assemblies are conserved from one thought to another. Most assemblies can be dropped or abandoned at the same time, i.e. when they become a lower priority. This readily happens when we are exposed to a new, salient, perhaps emotionally laden, stimulus. When this occurs, the octopus "jumps," taking all of its arms with it, and reorients to the new stimulus and its accompanying set of features. Such a jump would constitute a disruption of mental continuity. So clearly mental continuity can be viewed on a continuum where a high proportion of assemblies are conserved between brain states on one end of the continuum and a low proportion are conserved on the other end. Disruptions in continuity might occur due to a stimulus in the environment, or from an internally generated stimulus. Evolution has probably programmed the octopus to jump and reposition its arms quickly in order to respond to important sensory stimuli, so that mammals react to them with all of their cognitive resources. Mental continuity is less easily disrupted in humans than it is in other mammals, although perhaps more easily disrupted in people with habituation deficits. Attention and distraction must be intimately related to the temporal conservation of

assemblies. In fact, the extent of attention deficit and distractibility should be inversely related to the neurological capacity to conserve assemblies in association areas from second to second. Creating an operational definition for this proportion and ways to measure it (on a scale of neurons per millisecond) may prove informative and may represent a biological measure of general intelligence.

Another analog of this analogy is the idea that the octopus will "topple" if it loses its grip on a sufficient number of assemblies. This makes the body of the octopus analogous to consciousness because brains become unconscious once coactivation (especially in the frontal and parietal fields) is sufficiently diminished. Thus anterior-posterior balance and coordination are important for our allegorical octopus.

Subsequent sections will continue to explore this analogy in an attempt to relate it to hierarchical processing and other concerns. However, a number of things will remain unclear: 1) How is the extent of assembly activation limited in the cortex? 2) How close is the relationship between neocortical minicolumns and the present assemblies? 3) What organization of nearby, similarly-tuned neurons constitutes an assembly? 4) How localized or spread out are assemblies? 5) What is the role of rhythmic binding in assembly coactivation? 6) How do synaptic changes associated with learning affect ensembles or their assemblies? 7) What is the role of neocortical layers and hypercolumns?

Working Memory: The Coordination of 7 Plus or Minus 2 Arms

The total number of cortical ensembles (or assemblies) that can be coactivated must besomewhat stable given known limitations on things like neural excitability,

cortical hemodynamics and working memory. In our analogy the number of available octopus arms is very stable and this represents our fixed, innate capacity for working memory. Even though the number of chunks (psychologically perceptible units of perception and meaning) that can be held in working memory, 7 plus or minus 2, coincidentally coincides with the number of arms that a living octopus has (8), this is not a reliable indication of the number of ensembles that can be coactivated in association cortex. This is true because even though chunks and ensembles may be relatively congruent, the exact relationship between them is currently unclear. It seems clear though that the octopus has a relatively invariant number of arms and that perhaps, in order to bring a new ensemble into the train of thought it must first let go of some other ensemble. Surely the number of activatable assemblies/ensembles differs from area to area and from task to task, but it probably remains relatively constant within tasks. Relative to Baddeley's model of working memory(Baddeley, 2000; 2007), active ensembles spanning from association cortex: to visual areas can be equated with the visuospatial sketchpad, to auditory and language areas can be equated with the phonological loop and to the prefrontal cortex (PFC) equated with the central executive.

It may be correct to say that someone with a working memory deficit (because of mental retardation, intoxication, psychosis or dementia) has fewer of these allegorical octopus arms. Someone with a general mental deficit, temporary or chronic, probably cannot bring as many assemblies with them through time and may not be able to synchronouslycoactivate as many of them together simultaneously. Because assemblies work cooperatively to select the next brain state, having fewer assemblies of less duration

will reduce network searching power and specificity. In other words, it may be the case that, the larger the number of active assemblies, the more vivid and precise the mental imagery created in the mind's eye; whereas, fewer means less accurate, less precise perceptions (and less specific and pertinent memory recall). Similarly, the longer certain assemblies are activated, the more new thoughts are informed by recent thinking. An intelligent person, endowed with a large working memory, can prolong activation of certain assembliesallowing detailed priming and filtering of memory that allows the person to be perceptive and keen.

A deficient working memory (or one lower on the phylogenetic scale) may have the following characteristics: 1) fewer assemblies to select from (based on reduced cortical surface area and the resulting smaller number of cortical columns with unique receptive fields); 2) fewer assemblies bound during instances ofcoactivation; and, 3) the activation period of association assemblies is less long-lasting. The extended activation ofassemblies in association areas changes the learning process as well.

Prolonged activation causes synaptic changes to reflect higher-order, temporally-structured representations; altering the weights of receptive fields, tuning ensembles and their assemblies to be able to respond to even more temporally complex features in the future. Thus, fluid intelligence derives from the number and duration of assemblies, whereas crystallized intelligence derives from the connections between assemblies and their tuning properties.

<u>The Selection of New Assemblies: Where The Octopus Sends Its Free Arm</u>

The way that new assemblies are primed in this model is consistent with connectionism and spreading activation theory. In spreading activation theory, associative networks can be searched by labeling a set of source nodes which spread their activation energy to closely associated nodes. Nodes correspond to concept and knowledge units which may be congruent with our conceptualization of the unitary conceptual fragment embodied by a cortical assembly's receptive field. The propagation of activation follows weighted links to other nodes. Several alternate paths through these links can reach a specific end node. When enough of these alternate links reach the same node this node is likely to be activated. In the brain, these links are thought to represent connections between neurons or assemblies and the weights are found in the synapses. In other words, when a particular number of cortical areas are active they will converge on particular other areas according to the weights found in the network. Many areas will be converged upon weakly, other areas will be converged upon by inhibitory potentials, but a few areas will be converged upon enough to increase the frequency of action potential firing, which in turn increases metabolic activity.

A cortical cell has many inputs (in the form of synapses) and a large number of these inputs must be actively sending it neurotransmitters (creating excitatory post synaptic potentials) in order for the cell's firing rate to increase appreciably. Cells in the cortex are open to being activated maximally, but they remain at a resting level until just the right complement of inputs takes place. Once the cell becomes activated sufficiently, the cell will send outputs to other cells within its projective field. Further increases in activation may increase it firing rate. Increased firing of the cells that constitute an

assembly will lead to “ignition” of the assembly itself. On an assembly level, this happens when cells within the input layers become excited enough to activate the pyramidal projection neurons associated with the assembly, which fire out rapidly to the cells of other assemblies in the cortex. Inhibitory interneurons determine what neurons will be inhibited from contributing to their assemblies, and pyramidal neurons determine what assemblies will become active relative to the rest of the brain. I believe that the outputs of pyramidal projection neurons in sensory areas broadcast mental imagery by converging on downstream assemblies. Projection neurons in association areas, far downstream, recurrently direct and modulate this imagery through top-down, backpropagating retroactivation.

Because only a small minority of cells become highly active at any one time, many memories and much imagery remains dormant. Only the precisely appropriate cells are chosen and this creates the specificity of thought. It takes just the right combination of inputs from other primed areas (anywhere in the cortex and even subcortical areas) to pull these cells into the octopus’ embrace. Input from four associated assemblies may not activate a new assembly without the contribution of a fifth assemblies’s EPSPs. From a psychological viewpoint, we may not be able to recall a particular memory unless just the right combination of related memories are coactivated.

By the same account, sometimes arbitrarily associated assemblies are coactivated (and superfluous memories are recalled) because the brain cannot know beforehand if the memory will be applicable (unless it has had experience with this particular confusing set of coactivates). The brain uses a blind heuristic, summoning up the memories with the

largest numbers of related inputs. In other words, the precise combination of active assemblies determine together (by spreading activation) which assemblies will be activated next. This reasoning is consistent with the conclusion of psychologists that the thinking process works associatively.The implications of this neural "polyassociativity" are taken here to map on to psychological associationism meaning that reportable psychological states are a product of associations between the elements found in previous states. On a millisecond timescale, we do not pick and choose our thoughts, they are chosen for us based on how the currently active assemblies interact with the associative network. In this way, thinking appears haphazard because ultimately the way new assemblies are selected is not overseen by any rational process other than the historically selected architecture of the brain and thepolyassociative algorithm described. There may be no other hidden logic or computation aside from that found in the epigenetic structure of memory due to past learning. Thus, the fewer the number of assemblies coactivated to choose the next set assemblies, the more random, mercurial, deterministic and unguided this process appears. Again, such localized, well-connected assemblies are analogous to the suction cups on an octopus arm. The sum of these assemblies (which code for elementary features that alone do not capture attention) produces an ensemble (a trait which can capture psychological attention) that is then summed with other active ensembles to create the complete thought.

Ensembles can also be viewed as "microconstellations," theoretical or statistical subsets of existing "macroconstellations." A constellation of brain activity involves each of the firing neurons that contribute to cortical activity in a moment's time. This

constellation will hold a number of microconstellations, which are groups of neurons that ordinarily belong to a discrete function, process or concept but are now, in this moment, firing with the neurons of other functions, processes or concepts. Each of these microconstellations will belong to a much larger group of neurons that ordinarily fire during a particular function, process or concept, this would be a macroconstellation. Macroconstellations, again are a group of neurons that have shown a past tendency to fire together (and are thus wired together). However, all of these statistically correlated neurons never all fire at once. In fact, only their most relevant elements are picked and chosen by the other miniconstellations present in the brain. In other words, ensembles or microconstellations are fleeting subsets - temporary and limited instantiations of larger, theoretical macroconstellations. A certain macroconstellation would involve a unique group of brain neurons where some were more heavily involved than others. A macroconstellation could be expressed mathematically with a frequency distribution that delineating how many times each neuron in the brain fired with it. The tonic or persistant activity of PFC neurons allows larger, more complicated macroconstellations that span longer time domains. Getting back to the topic, as microconstellations coactivate they flesh each other out, forcing each other to change by adding and subtracting components of their respective macroconstellations. Most microconstellations pivot around the microconstellation that is given the most dopamine. The stream of thought then, takes temporally discontiguous macroconstellations and weaves them together creating new ones.

<u>The allegory of an interactive TV: How the octopus guides mental imagery</u>

This model is also consistent with the consolidation hypothesis which states that memory is stored in the same areas that allow active, real-time perception and function (Moscovitch et al., 2007). Relatedly, it assumes that remembering (or imagining) a particular sensory image largely activates the same neural networks that are involved in actually perceiving the imagery in the environment (Crick and Koch, 2003). Thus, the available population of assemblies in sensory cortex act as an active canvas for either the environment (via feedforward connections), or expectation (via feedback connections) to paint on.

This section will attempt to explain how coactivated assemblies combine to create mental imagery, how features of images come together and how subsequent images are chosen. To do this we will consider hierarchical brain processing. [To a certain extent, the cortex is organized hierarchically. The primary visual area (V1) (along with the thalamus) processes the stream of information sent to it from the retina allowing it to distinguish dots. The secondary visual area (V2) puts these dots together to form lines- the edges and curves that make up the visual scenery. Even higher-order, "downstream" areas put these lines and curves together to discern more complex visual features amounting to the recognition of movement, color and even objects, scenes and faces. Imagery is created in sensory areas as sets of assemblies pool their activation energy and converge on assemblies with higher-order, more specific receptive fields. Now we turn to how the cycling of information between lower-order, bottom-up areas and higher-order, top-down areas is accomplished and worked into our conceptual schema of the octopus.

In other words, this section will address how imagery is created, interpreted and then modified.

Here, their spatial and temporal frequencies were given the chance to excite existing neural networks in order to determine if their features mapped on to anything I had experienced before. This message was passed from the primary sensory areas to secondary sensory areas, where they excited assemblies that corresponded to their unique traits, allowing more detailed identification of structure and form. Then the messages traveled from the secondary sensory areas to higher order, more globally communicative areas.

We will now describe the brain events involved in a cycle between internally generated imagery and our higher-order perception of it, i.e. the- reciprocal activation between sensory and association areas. This process is similar to what it would be like to watch a television program, one that can be controlled with ideas, conceptions and conceptualizations. Similarly, the early auditory area can be equated with a tape recorder that can be recorded upon and played back. The early visual areas constitute the TV in this analogy because, unlike association areas, they map imagery that is spatially or retinotopically bound to the visual field. Early visual areas take inputs from higher association areas and, given these specifications, paint metric imagery. Importantly, things that follow from our abstract conceptualizations, but that we did not expect to see, are routinely rendered in imagery. For instance, our sensory areas might pull up the imagery specified by association areas, but elaborate on it with closely associated but unforeseeable embellishments. Thus, the cyclical oscillations of information between

sensory and association areas allow them to learn from each other, and to integrate their knowledge like two people in a conversation. The fact that they have fundamentally different perspectives on the world makes the "conversation" between them dynamic and informative for both because of the lack of redundancy. The crosstalk is similar to that between two specialists in related areas, speaking the same language and interrogating each other about the nature of their common interests.

This analogy of the "TV you control with your mind," represents the process whereby higher-order (top-down) association areas interpret and then control sensory imagery in early (bottom-up) sensory areas. The higher-order association areas influence this imagery through their outputs to sensory areas, and then receive feedback from the sensory areas (as if the created imagery is actively "watched" to permit feedback). At this point, some of the association areas remain activated because they are restimulated by the imagery. Other association areas that are not restimulated or those that are stimulated by inhibitory neurons might deactivate. We create imagery in our minds, but we do not necessarily pay attention to every aspect of the imagery, as we do not necessarily notice every aspect of the perceptions created regarding our environment. When an association assembly contributes to mental sensory imagery in a way that is not noticed by association areas in the next cycle, that assembly is not reactivated and does not contribute to subsequent imagery until reactivated. The sensory imagery that is generated is not seen as a whole as we might like to think. In fact, many features of the mental imagery that is created probably remainpreattentive. Thus this analogy of the "TV you control with your mind" can be combined with the octopus analogy because the elements

of the TV that are noticed drive the placements of the octopus' free arms. Technically, the imagery in early association areas also involves assemblies and thus the concept of the octopus arms as well.

Antonio Damasio has proposed that early sensory cortices construct image space and that association cortices construct dispositional space that does not hold any imagery itself. In my opinion, association areas do hold imagery. They hold imagery of higher-order concepts that are disoriented from spatial mapping or retinotopic coordinates. In other words, visual sensory areas hold spatially-oriented optical imagery, auditory sensory areas hold temporally-oriented sound imagery and association areas hold abstracted, multimodal, conceptually-oriented imagery that is relatively free of reality-imposed, unimodal, spatio-temporal constraints. Contrary to Damasio's notion that association areas only guide the construction of imagery, I think that association areas can hold true imagery in the sense that they can invoke high-level perceptions of things that the person can become conscious of. However, consistent with Damasio, this model agrees that association areas do not possess all of the information held in the early sensory cortices that converge upon them. The firing of a grandmother neuron in the anterior temporal cortex alone does not produce a conscious visual depiction of a grandmother in the mind's eye. In other words, you cannot visualize a spatial, line-bound image of your grandmother without early visual cortex. However, without early visual cortex, you can still hold associative, conceptual imagery about her as long as your anterior temporal cortex is intact. In this sense, the imagery (its construction, and manipulation) is truly in the process of bottom-up to top-down reciprocal oscillations.

How the dynamic pathways between assemblies interact with one another and the extent to which historically unrelated assemblies cooperate to drive new images is still poorly understood. Higher order association areas are less useful if early visual cortex is destroyed because they were meant to interact with the early areas. The same goes for early sensory cortex without higher association centers, the two were designed to interact and have interacted together throughout development so each is lame without the other.

I propose that the early visual cortex activation creates vibrant and specific internal imagery simply because it has become correlated with the appearance of this imagery in the environment. Brain cells create a theatre of the mind because they have "taken on" certain external properties. Imagery is held everywhere because each part of the brain has become correlated with some type of environmentally induced experience. Like the neurons responsible for the sensations in a phantom limb, early visual neurons "hold" the experiential properties of experiences that they have been correlated with in the past. Surely anterior association areas have been correlated with experiences, albeit abstract ones. Thus purporting that association areas do not hold true imagery is like saying that imagery is held in the dots of primary visual cortex but not in the lines of secondary visual cortex. –This is wrong. The firing of neurons is not correlated with sensory experience, it is sensory experience. When you imagine something, you experience it again, in a half-baked way, you fire the same neurons that fire when it is experienced.

Even though the brain is a very dark place and neurons themselves cannot generate light, early visual areas have been tuned by experience to represent variations in

brightness, color and form, so that when they become active, from either retinal or top-down inputs, they display vibrant imagery. It may be correct to say that only sensory areas constitute this TV, and that association areas hold higher-order concepts that drive image construction within the TV. On the contrary, the association areas may just be extensions of the TV because they, like the sensory areas, are turned on every time a specific visual concept is invoked so there is no reason to assume that they do not hold their own form of imagery. Arguing that association areas do not hold imagery is tenuous and is akin to saying that only V1 holds imagery, and that V2 simply modulates the imagery. Thus cortical areas responsible for visual processing - from the posterior occipital pole to the dorsolateral prefrontal cortex – lie together on a continuum with retinotopic imagery on one side and abstract, conceptual imagery on the other.

The progression of thought involves oscillatory messaging between bottom-up sensory imagery and top-down interpretations of that imagery where none of the brain areas know exactly what they are going to invoke in the areas they are communicating with until they receive feedback. The brain probably does not make any plans about how sensory areas will integrate the various association inputs, it simply does so reflexively based on prior probabilities. At first it seems that early sensory areas would have a difficult time integrating multiple concepts from association areas into a single, meaningful image. However, the ability to take incongruous elements and integrate them has become the sensory cortex's specialty as, over developmental time, it has been trained to do this with environmental perceptions.

The process of reconstituting diverse association specifications into sensory imagery is probably identical in many ways to the way that sensory areas combine features of the sensory environment to create early sensory perceptions. When sensory areas create perceptions based on inputs from the retina they construct scenes by conjoining dissimilar elements into a cohesive interpretation based on what they have been rewarded for creating in the past. Sensory areas must do the same thing with inputs, not from the retina, but from the association areas to create imagined imagery. This suggests that one can only perceive the relationship between two abstract ideas if one already has implicit information in the sensory cortex (and its hierarchical network of structural descriptions) about how to co-represent them in an image. If the person is missing instrumental conceptual knowledge in their sensory areas then these areas will not be able to create the image (although it is possible that association areas could manipulate a series of images to lead up to a final image where the important elements are depicted retrospectively). In turn, things that had not been considered prior are brought up on the screen, important things that help to guide our train of thought, things that only our unconscious visual memory system can conjure up.

The reciprocal activity allows sensory and association areas to learn from each other. Association areas might as well be saying to themselves: “Well, it will be interesting to see how the visual system will combine this unique set of higher-order coactivations into a composite, lower-order, feature-based image.” This sensory image does what association areas cannot do on their own – take various components and integrate them into a visage that is environmentally veridical. The way that sensory areas

integrate when they construct images is informed directly by reality, as they have been tuned directly by real environmental inputs, unlike associative areas, which are tuned indirectly by reality due to the intervening effects of motivation, temporal delay and inference. The whole reason that these coactivations make a perception that is good is that this early visual system has been exposed to so much sensory information, it has a huge repertoire, accumulated over time, of tricks and insights into how physical and psychological things work. The sensory activations potentiated by the sum of coactivated association areas determine the next group of association assemblies that will be activated- the placements of the octopus' free arms.

What happens psychologically when multiple sensory assemblies are coactivated together to form an imagined perception? I believe that, when this happens, mental imagery is created of the sort that we are all accustomed to seeing in our mind's eye. The cortical assemblies that we have been talking about, that can be primed by internal inputs, also correspond to brain areas that are primed by external inputs during sensory perception. In fact, early sensory assemblies were first tuned by external inputs- sensory experiences that we have been having since before birth. When these assemblies are activated by the environment we have a sensory perception - a rich and vivid experience that can involve any sense but the most vivid and highly processed are probably visual and auditory. As an association assembly is converged upon from sensory assemblies upstream, it becomes active and in turn divergently reactivates the upstream sensory nodes that just converged on it, and additionally may also activate the other nodes that ordinarily converge upon it. The resultant sensory imagery is then either superimposed

over objects perceived in the environment (during perception) or combined with other features in the mind's eye (during imagination).

When we think and imagine, we activate early perceptual networks. The PFC and other associative areas do not appreciably influence processing in V1 or the LGN of the thalamus (the earliest of visual processing areas) via recurrent projections, but can profoundly influence the activity in extrastriate visual areas. Thus, contemplative thought takes place on the same Cartesian stage that the sensory experience takes place on. To me there is far less mystery left about the origin of conscious imagery after this is taken into account. Sense, remembered or reactivated is the substrate of thought. The unique pattern of coactivations that are primed in the cortex by a particular external visual scene is perceived as a sensory image. An internally driven sensory image is a pattern of coactivations in sensory cortex that is not primed by information from the retina, but information from higher-order association areas. The internally driven imagery does not activate sensory areas as much as a true sensory experience does, and this probably accounts for why imaginary imagery is not as vivid as actual imagery. Internally driven imagery, on the other hand, probably activates higher-order, top-down, association areas more than does true sensory experience. Both externally- and internally-generated imagery have the capacity to activate higher-order sensory areas. In other words, we can alternate sequentially from externally-generated imagery to our higher-order perception of it; we can alternate reciprocally between internally-generated imagery and our higher-order perception of it, or combinations of both.

Our visual sensory cortex is composed of primary and secondary sensory areas known to have their own very short-term memory called “sensory memory.” Sensory memory has been shown to hold more than working memories’ 7 plus or minus 2 chunks, although it does so very fleetingly (2.5 seconds for auditory sensory memory, and 250 milliseconds for visual sensory memory). Mental imagery probably works in much the same way in the sense that the imagery holds more information than we can consciously attend to and that it fades within a quarter of a second if it is not bound to, or reactivated, by higher-order associations. In other words, there are many association assemblies watching the fast-paced TV but these will only respond if they are adequately activated.

Importantly, this cycle demonstrates how Baddeley’s visuospatial sketchpad and phonological loop operate. Psychologically this feels as if new concepts evoke apposite imagery which we then analyze and modify. Our sensory areas conjure up their best sensory representation of the concepts the higher areas developed and, given the specifications handed down to them, use receptive fields and prior probabilities to present this visage. This ability is probably fine-tuned during early visual development, and probably makes use of the vast architecture of recurrent (back-propagating) pathways and is accomplished rapidly and automatically. The nervous system is wired in a way that almost all cortical-to-cortical connections can go both ways. The sensory imagery generated causes association areas to think of something else, something that could be a slight modification on what we saw last, or seemingly a paradigm shift away from it. The next configuration of octopus arms may seem wildly different, because it evokes a different sensory image, but unless emotions were evoked, it is likely that many of the

high-order arms are still in place even when the early sensory imagery changes profoundly. Hence, sequential images created on the TV may look very different but they are likely to be highly interrelated.

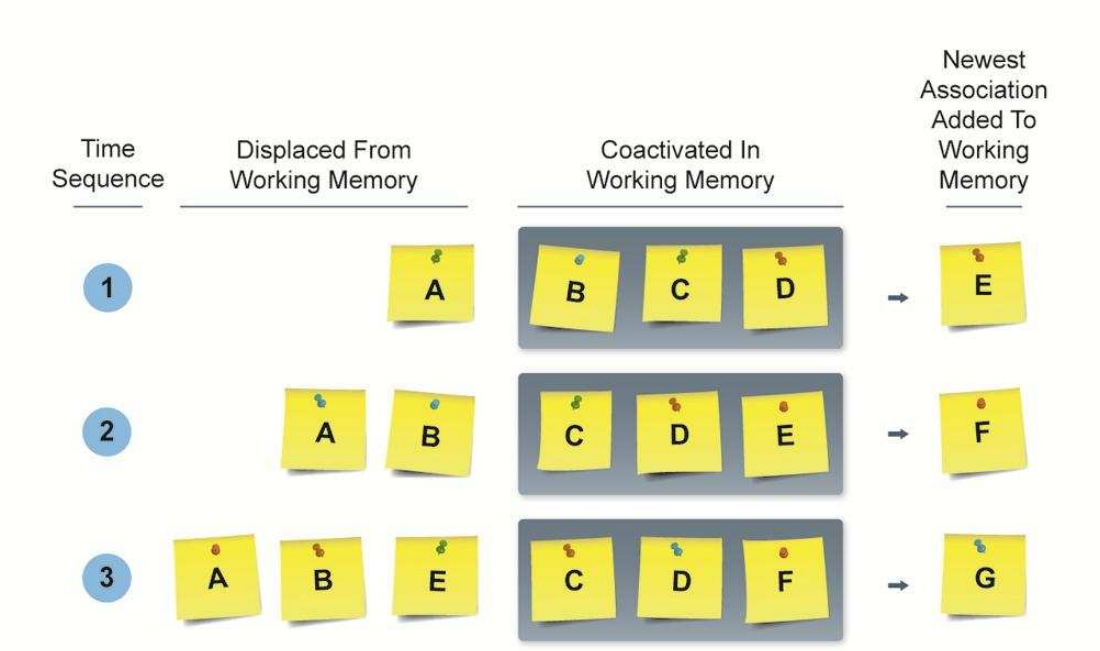
One might ask then, where and when does consciousness happen? Most neuroscientists agree that, when considering sensory information from the environment, lower-order, primary areas are activated, then it takes a quarter of a second to become aware of the information. This time is thought to correspond to the time it takes for these lower areas to activate the most important high-order area, the PFC. Once the PFC becomes aware, we are thought to be conscious of the sensory stimulus. This makes some sense that associative, convergence areas such as the PFC, hippocampus, and the angular gyrus must be activated for us to become aware of something. But these areas do not contain vivid sensory imagery, at least not the kind we associate with sight for instance. Because of this, we probably have to wait for the PFC and other high-order areas to contact sensory areas in order to experience our response to a stimulus. What does it mean to be conscious of something if we have not yet responded with imagery? Maybe consciousness is the ability to form new imagery from previous imagery. Then there is the question of how many times we have to re-experience our response to lower-order imagery for us to be "aware" of it. It seems that this happens as soon as assemblies associated with imagery related to self-awareness are activated. We may be conscious of the early sensory imagery, that is the experience that we remain in through time. But the association cortex is the buffer of coactivating concepts that actively selects what mental imagery we see next. Only personal insight allows us to see this.

The octopus' momentum moves it inexorably, mechanistically and deterministically to the nearest associated concepts, these connections are hard-wired like a fixed action pattern. The PFC and hippocampus though can modulate the octopus movement in order to reflect a past experience (the hippocampus), or a past motivation (the PFC). Hippocampal pattern completion helps the octopus place a number of its arms on a constellation of assemblies that were activated at some point in the past. The PFC helps the octopus maintain its position, in the sense that it trains and controls the spatio-temporal layout of coactivations, it also pins a few arms down at a time to allow planning and modeling. The hippocampus and PFC work together too. The PFC keeps several things active long enough so that when the hippocampus takes a snap shot, the snap shot contains several different activates.

How Thought Propagates

Thought is made up of the comingling of several concepts at once. In the brain, this involves the simultaneous firing of all of the neurons that represent each of these comingling concepts. The various neurons involved coactivate together and spread their activation energy leading to the activation of neurons corresponding to the concept that is the most closely linked (associatively or causally) to this particular set of concepts. Every second, as thoughts change, old concepts are removed, new ones are added, but yet a large number persist. Figure 3 includes a diagram attempting to show how concepts are displaced, newly activated, and coactivated in working memory to form the "stream" or "train" of thought.

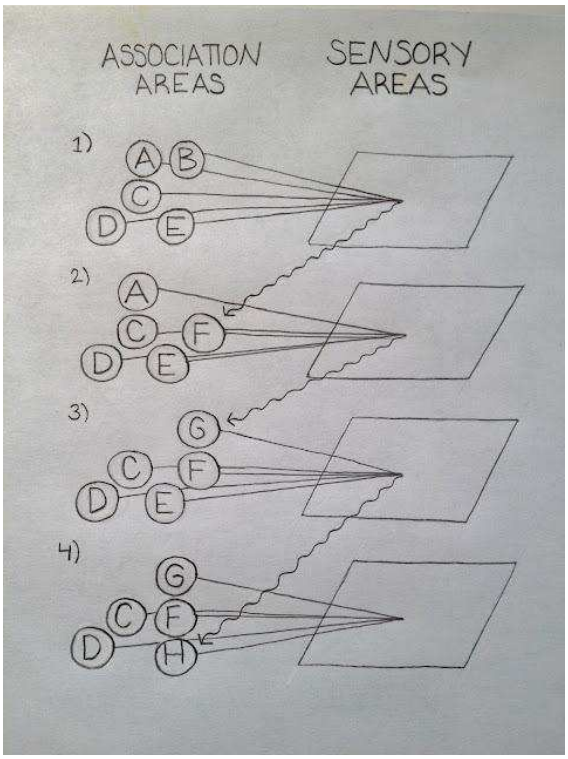
Figure 3: Selection, Inclusion and Displacement in Working Memory



Note: Each concept is represented by a letter and the order in which they are pulled into consciousness follows alphabetical order. 1) Shows that concept A has already been displaced from working memory and that now B, C and D are coactivated. When coactivated, these concepts combine (or spread) their activation energy to activate a new concept, E. Once E is active it immediately becomes a coactivate, restarting the cycle. 2) Shows that concept B has been displaced from working memory, C, D and E are coactivated, and F is newly activated. 3) Shows that concept E, but not C has been displaced from working memory. In other words, what is displaced is not necessarily what came first, but what has proven, within the network, to be the most valuable to the given set of coactivates. C, D and F coactivate to make G active. Importantly, it would be almost impossible to break down the activation dynamics in the brain into discrete time frames as is shown here. Also, this model makes it seem that only three concepts are coactivated at a time, whereas this number would be larger (maybe "7 plus or minus 2"). Further, the concepts that are displaced from working memory may not be in immediate cortical memory, but may still be held in another form of working memory that involves cortical priming or hippocampal memory. This scheme makes it seem that it is only the concepts that we consciously experience that activate subsequent concepts, but the concepts (or nodes) that are unconsciously primed also contribute to the activation of subsequent concepts.

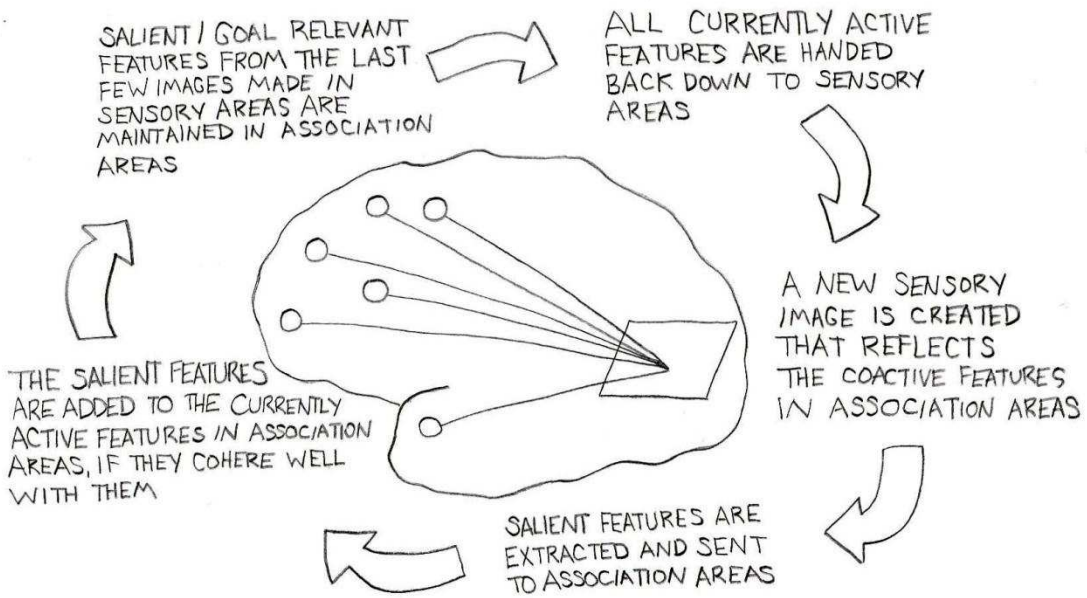
Consciousness and working memory are driven by the reciprocating cross-talk between fleeting bottom-up imagery in early sensory cortex and lasting top-down priming in late association cortices. The figures below attempt to explore how this reciprocal interaction works.

Figure 4: Frontal Association Areas Selectively Preserve Sensory Features



Note: Each concept held tonically active in association cortex is represented by a letter. The order these letters are pulled into consciousness arbitrarily follows alphabetical order. 1) Shows that concepts A,B,C,D and E all diverge onto posterior visual sensory cortex. 2) Shows that neurons involved in the retinotopic imagery from figure 1 converges on the association neurons responsible for holding concept F. It also shows that concept B drops out of activation, and that A, C, D, E and F diverge back onto visual cortex. 3) Shows that this same process leads to G being activated and A being deactivated in association cortex. 4) Shows that H is activated and that E is deactivated.

Figure 5: Features Cycle Between Association and Sensory Cortex



Note: Sensory areas can only create one sensory image at a time, whereas association areas are capable of holding the salient or goal-relevant features of several sequential images at the same time. In other words, neurons in association cortices can remain tonic for a number of seconds, making activity there progressive because it can reflect the most important aspects of several successive instances of sensory activity. Dopamine is key to this progressive process because it helps to determine which features are relevant/motivating.

The process described in Figure 5 can be described by the following list:

1) Sensory imagery is made in early sensory cortex. This is either a product of feedforward sensory information from sense receptors or from downstream retroactivation.

2) Salient features are extracted and communicated with higher association areas

3) Salient features that cohere with already active features in association areas (that are consistent with the present set of concerns) are added to the active features there, whereas the least relevant features in association areas are dropped from activation.

4) The important features of the last few images are maintained active in association areas.

5) The new set of features is handed down to early sensory areas.

6) This new set of features is used by early sensory areas to construct topographic imagery. In reality, sensory cortex from each sense modality feeds their inputs to association cortex (and to each other).

7) The process starts over.

If it were possible to pause a mind at a single instant and look carefully inside the brain, we would see that some brain cells are active and others are inactive. How long these neurons continue to fire after the mind is unpaused is determined by how much input they are getting from other active neurons. If they are not being sent more than the requisite number of messages from their peers, they slow down or turn off. Some of the currently active neurons will remain active for only a few milliseconds, others for large fractions of a second and others for several seconds. None remain active indefinitely, but rather they each persist for different durations. The pattern of activity in the brain is constantly changing, but because some individual neurons persist during these changes, particular features of the overall pattern will be conserved over time. In other words, the distribution of active neurons in the brain transfigures gradually from one configuration to another, instead of continually changing all at once. I believe that the persistence of certain neurons allows the temporary maintenance of mental imagery which is a central hallmark of consciousness and working memory. I also believe that this persistence lends continuity to the train of thought.

Six years ago I was waiting at a bus stop wondering how my mind is different from that of other animals. I realized that my thoughts can extend further in the sense that I can carry a complex concept out to its logical conclusion. I can take more information with me through time before I lose it and forget what it was I was just thinking about.

Psychologists agree that working memory, or the ability to preserve information and perform manipulations on it, is more highly developed in humans. Influenced by the various lengths of different pine needles on a Douglas fir at the bus stop, I concluded that human thoughts were somehow "longer." But if thought has a length associated with it, then it must have a beginning and an end too. I wondered for a while if thoughts really do begin and end, and if so, on what time scales. I now believe that it is possible to answer these questions using the reasoning in the previous paragraph.

Thoughts have length in a sense, but thoughts do not have a clear beginning or an end. Thoughts are "longer" in humans because they are composed of elements (that correspond to individual neurons, or neural assemblies) that remain active for longer periods than they do in other animals. Our large prefrontal cortex and association areas keep some neurons online for several seconds at a time, whereas in our pets, for example, most neurons remain active only very briefly. So it is not that individual human thoughts are longer, it is that our thoughts are composed of elements that remain coactivated for longer. The neurons that persist stop and go at different intervals. It is not the case that all of the neurons that persist turn on and off simultaneously. In fact, the beginning of the activity of one neuron will actually overlap with the tails of others. The neurons act like racecars that join in and drop out of a race intermittently. Their behavior is staggered, insuring that we continually have a cascade of cognitive elements that persist through time. Thus there is no objective stopping or starting point of thought. Instead, thought itself is composed of the startings and stoppings of huge numbers of individual elements that, when combined, create a dynamic and continuous whole.

Sensory neurons in the back of the brain do not usually remain active for long. It is the anterior, association areas, especially the prefrontal cortex that contains neurons that stay online for seconds and even minutes at a time. These neurons, by remaining active, can mete out sustained signaling to other neurons, insisting that the representations that they code for are imposed upon the processing of other neurons that are firing during their span of activity. This is why the prefrontal cortex is associated with working memory, mental modeling, planning and goal setting. The longest, most enduring element or neuron would correspond to what the individual is most focused on, the underlying theme or element that stays the same as other contextual features fluctuate. Thought changes incrementally during its course. We picture one scenario in our mind's eye and this can often morph into a related, but distinctly different scenario. Our brain is constantly keeping some elements online whether they are representations of things that are concrete and tangible or abstract and conjunctive. I think that neural continuity as described here is an integral element of consciousness and may be a strong candidate for the "neural correlate of consciousness." Philosophers and neuroscientists have identified many different elements of brain function (thalamocortical loops and reentrant cortical projections) and attempted to explain how these may lead to conscious experience. I think that the present concept of "continuity through differential temporal persistence of distributed neural activity" is instructive and I even feel that it is the core aspect of conscious experience, qualia and phenomenality.

Conclusions

Described herein is a low-level model that proposes some general patterns of mental activity in terms of neuroanatomical space and the spreading of activation between processing units over time. These writings are exploratory and at times superficially reductionistic. Many important concerns were left out of the discussion. Mental activity was likened to the "polypedal locomotion" of an octopus that is "seafloor walking." This octopus leaves the majority of its arms where they are and only moves an arm when the foothold it is placed on is distant. This is meant to show that we drop neural assemblies when their relevance to the processing demands diminishes. When one arm is removed, the concept corresponding to that branch becomes deactivated and no longer informs present thought.

How is the mind like an interactive television? It is a continuous cycle between coactivations in higher order areas and those in lower-order (primary and secondary sensory) areas. The lower order imagery automatically activates a new set of higher-order nodes that are tuned to the different features of the lower order imagery. These newly activated higher-order nodes are added to the remaining previous nodes (or octopus arms that remained on the past branches) to create a unique set of coactivations that again (via recurrent connections) activates lower order sensory neurons that are responsible for pulling up a new scene of mental imagery. It is a continuous cycle between coactivations in higher-order areas and those in lower-order (primary and secondary sensory) areas. The important point is that the priming lasts longer in the higher-order areas and the lower order sensory areas can be wiped clean quickly to accommodate a new picture. The

lower-order sensory areas probably last just as long as sensory memory whether they are activated by the environment or by higher-order areas. The octopus is always straddling the line between bottom-up and top-down and the arms (or assemblies) on the bottom-up side move faster.

The vast majority of mammals have small prefrontal cortices so they rarely have assemblies that remain active over a number of brain oscillations. It is probably maladaptive for animals to prolong the influence of a particular feature that is not found in the environment. The persistence of assemblies probably causes animals to react slowly to their environment because their imagery is influenced by past concerns instead of very present concerns in real-time. Mental continuity slows the octopus down. The continuity provided by the PFC allows systemization of the environment and higher-order learning, things that our species adapted to necessitate. Most other vertebrates do not need this kind of continuity to create adaptive behavior, they probably find the persistence of working memory distracting, noisy, and task-irrelevant. It all depends on the nature of the tasks that the animal is confronted with in their neuroecological setting. This is why most mammals learn from trial and error more than from mental modeling. Assembly activation in most animals is due to external stimuli in the environment: sensory areas are activated by environmental inputs, these then activate association areas, which in turn activate motor areas, then the animal waits for the next group of stimuli. Humans can activate their sensory areas using only internal, associative stimuli, allowing a powerful reciprocal loop between association and sensory areas.

The process whereby neural assembly activation fluctuates spatio-temporally is taken to be analogous to the nonlinear stride of an octopus that plants the majority of its arms temporarily, while actively repositioning arms that have let go of their footholds. Here, each individual cortical assembly is thought to be tuned to code for a discrete element of long-term memory. When multiple assemblies are coactivated the individual elements can be united into composite, mental representations. These representations fluctuate back and forth between early, bottom-up sensory cortex (where they are metric and topographic) and late, top-down association cortex (where they are abstract and conceptual) on the order of brain oscillations. Sensory areas and association areas continually stimulate each other into building interpretations of the other's outputs resulting in a conversational interchange with minimized informational redundancy.

Humans hold, in their memories, countless examples of non-reconciled conceptual representations. You may have knowledge of two facts, that when put together (when their elements are coactivated together in the automatic creation of imagery) create new knowledge. For example when one coactivates a present scenario with a psychological schema, the schema will inform their interpretation of their present predicament. If the schema was not recalled and its nodes were notcoactivated with the current nodes, they would never be reconciled, no imagery depicting their integration would be created, and the person would continue acting without the knowledge provided by the schema. When you forget something, you failed to integrate an important memory. In other words, memories are discrete and are usually only integrated during conscious, associative thought. Two pieces of related knowledge are only reconciled if they are

pulled into the octopus' embrace, and are corepresented in an image, or in a related sequence of imagery. Thus, thought is the process of the construction of imagery in early sensory cortices in response to a particular set of coactivated assemblies in association areas. The thought changes once association assemblies respond to the elements of this imagery that they are sensitized to, and in turn, project recurrently to early sensory areas for the creation of modified imagery.

Maybe all of these bottom-up to top-down reciprocations are organized into oscillations that propagate in regularly timed intervals, across the brain so that they do not interfere with each other. The oscillations reciprocate back and forth at just the right speed so that each area has the time to process its inputs before re-projecting so that they have time to finish processing before they get the next complement of inputs. Messaging would be muddled if areas were to get information while they are processing, or if they didn't receive all of their inputs at the same time. Perhaps these bottom-up to top-down cycles of imagery map neatly to the synchronized oscillations of neural populations known to give rise to macroscopic oscillatory electric fields, which can be observed in the electroencephalogram.

A longstanding debate in this field has been between connectionism and computationalism. The present hypotheses have been largely connectionist as they emphasize the importance of interconnected networks of simple and often uniform units rather than modeling the "computational manipulation of explicit symbols." Scientists comparing human brains to computers sometimes assume that the brain accomplishes what it does by performing vast numbers of calculations or computations, using hidden

logic and special algorithms to process inputs into outputs. Are neurons logic gates that perform Boolean algebra like any other Universal Turing Machine? The present arguments would not directly support the notion that the brain computes solutions to problems, but that it retrieves them from memory. It seems clear to me that this is not going on. Life experience gives the functional structure to these processes that illusorily appears to be computation. Surely much of the function can be quantified and turned into math, but I believe that the connectionistic function must be understood before insights into the processing will be gained from the mathematics. Unlike a CPU, the knowledge and memories of a brain, like that of a neural network, are distributed throughout its connectivity. Understanding the world by finding invariant structure in the constantly changing stream of input.

Crick and Koch have advocated that neuroscientists should concentrate on finding the neural correlates of consciousness, defined as the smallest set of brain mechanisms and events sufficient for some specific phenomenal state. This article has suggested that node transience/persistence is a key correlate of consciousness. Also, here the significant neural correlate of consciousness (NCC) is taken to be open and rapid communication between sensory and association areas where sensory areas are creating imagery, and association areas are attending to aspects of the imagery by activating the higher-order assemblies that best correspond to these aspects, given the association assemblies already active. Binding then does not occur due to coactivation alone, but via the convergence of coactivated features in both association and early sensory areas.

Chapter 10: The Unconscious Mind and Belief

"We hear and apprehend only what we already half know."
-Henry David Thoreau

Modern psychology and neuroscience routinely operate under the assumption that, apart from the mental processes that we have conscious access to, there are many other brain processes that contribute to our thoughts and behaviors that we cannot consciously access. Some of these unconscious processes are accessible to consciousness but ordinarily go unnoticed, other processes are not accessible to consciousness at all but can be inferred from behavior. An example of the former is when we do something but never examine the preceding thoughts that lead us to do this thing. An example of the latter is when we do something and there are no directly preceding thoughts. Pinpointing unconscious processes and understanding their causes can be very difficult despite the fact that they are ubiquitous and constant. Unconscious processes are thought by most scientists to guide and scaffold not only our physical coordination, but also perception, memory, decision making, motivation and even consciousness itself. All aspects of our behavior, because they are influenced by either innate tendencies or forgotten past experiences, are thought to be affected by unconscious factors.

There are a large number of mental phenomena recognized by cognitive neuroscience as unconscious. Related phenomena include unnoticed emotions, underappreciated motives, subliminal perceptions, unfinished thoughts, hidden phobias, concealed desires, automatic skills, procedural habits and bodily reflexes. A popular

example of an unconscious process is the way that people respond to some subliminal messages without being aware of the influence. This is a prototypical example of an unconscious process that most people can relate to. Subliminal messages do not just come from external, environmental stimuli, they also come from within. We will explore a number of such processes, analyze the similarities and differences between them and attempt to create a kind of taxonomy of unconscious phenomena.

We will conclude that behavior is unconscious when neural structures in the brain influence thought or behavior without sharing the full content of their processes globally, making it unavailable to the spotlight of consciousness. I have posited before that when someone becomes conscious of something, prefrontal and parietal association areas, guide the construction of mental representations (usually visual or auditory imagery in sensory areas) of this thing. Therefore, any process that takes place without being recognized by association areas, and subsequently depicted in sensory areas through mental imagery, goes unnoticed and is unconscious.

But this definition is not sufficient to account for all of the various related unconsious phenomena that we will encounter. Because science does not have a thorough definition of consciousness, attempting to delineate unconscious processes proves extremely difficult. Perhaps, though, a thorough definition of unconscious processes will help us define consciousness. In turn, because beliefs cannot be unconscious, this survey into the unconscious will help us to better understand what neurological forms beliefs can and cannot take.

Background

The science of psychology has made tremendous advancements in the past century in its understanding of the unconscious mind and of the automatic processing which underlies it. These advancements have been made in response to a very large amount of evidence that has shown that human behavior is highly influenced by brain procedures that are not recognized by or perceivable to conscious thought. Modern psychological research has thoroughly examined and recorded many observable effects of these unconscious, automatic influences but it has only begun to define the psychological and neurobiological nature of them. Currently the unconscious is viewed by science and philosophy as somewhat enigmatic. Although this chapter does not hope to fully explicate this enigma, it does hope to detail a paradigm for use in analyzing its periphery.

The anthropomorphic, clinically oriented ideas that were established by theorists who initially developed the concept of the unconscious have strongly affected the modern view. Intellectuals such as Sigmund Freud and Carl Jung personified the unconscious as something that had a mind of its own. Because of the limitations of their day, these theorists were not able to analyze the mind or the unconscious from a rigorously biological perspective. As unconscious processes are primarily biological in origin, this perspective is necessary. British psychologist C. Lloyd Morgan famously stated that "In no case is an animal activity to be interpreted in terms of higher psychological processes, if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development." I believe that Morgan's canon should

similarly be applied to the unconscious. Scientists should avoid anthropomorphizing it unnecessarily.

Some modern neuroscientists, psychologists and philosophers seem to think that all unconscious processes can be attributed to an unconscious mind that itself is a mysterious entity that is highly analogous to the conscious mind. This is probably because some unconscious behaviors such as the unfolding of dreams, the telling quality of free associations and the curious validity to many Freudian slips appear to be guided by an intelligent source. These examples will be framed as the results of brain areas acting autonomously - in intelligent ways - but only because they have been programmed with these simple forms of intelligence through their interaction with the conscious brain areas over the span of many years. Not only have brain areas that act automatically and autonomously been programmed by higher-order brain areas, but they have also been programmed by the environment and thus they contain veridically associated elements of objective reality. The primary visual area by itself is dumb and deaf and practically blind, even to its own visual representations, but because it has been programmed by real visual phenomenon in the environment it has its own form of intelligence in the structure of the representations that it is capable of building. In other words, lower brain areas that serve as slave units to consciousness can create quasi-conscious outcomes when they act on their own. These outcomes, even when they seem to involve intentionality or epiphenomenality are merely phantoms of volitional behavior. It is only the effects of the complex interactions between brain processes and memory then, that take true unconscious processes and weave them into the apparition of an unconscious mind.

If the cognitive unconscious was not guiding conscious thought, scaffolding it and handing it relevant associations, it could not exist on its own. It is important to mention that even though conscious thought guides the mental imagery that is created, it is painting it with experiences and memories that mostly remain preattentive. Everything implicit in the mental imagery that we create is unconscious, only the aspects of the imagery that we notice and attend to, become conscious. Associations that were made conscious in the past are often not noticed or attended to directly but still "feel" like they are more than implicit simply because we could make them conscious if we attended to them.

It is the position of this author that it is only the conscious mind that engages in elaborate, meaningful analysis and what is thought to be the unconscious is actually a non-thinking byproduct of memory that enables both animals and humans to streamline processing and conserve cognitive and metabolic resources. The unconscious may be programmed in an intelligent way, but is not itself intelligent because it does not have the capacity to deliberate over prolonged time periods. Most of its processes carry to completion quickly and although this facilitates intuition, snap-judgments and loose associations, it obviates dedicated reasoning, extended analysis and algorithmic logic. The high-level conclusion that we are approaching here is that unconscious processes do not involve prolonged, persistent activations of cortex and thus are simpler than those that do because transient activations do not persist long enough to allow the global coactivations necessary for conscious thought.

For over a decade, I have had an urging intuition that consciousness can be reduced to unconscious processes. Finally, I have come to the conclusion that this is true on neurobiological grounds. As discussed in the chapter on the octopus analogy, unconscious perceptions and associations are bottom-up processes that can be activated for a prolonged duration if they are selected by the PFC due to their relevance in goal direction. When a module (brain area responsible for a feature of memory) is activated for more than one cycle of reperception it creates a certain amount of continuity (uninterrupted global persistence) between subsequent thoughts that unconscious processes cannot maintain. In other words, consciousness is simply unconscious, associative processing with the continued activation of some processes (modules or neural assemblies) over successive thoughts (neural oscillations). This feature of continued activation augments associative searches by allowing specific features to be used as function parameters (to serve as coactivates) for more than one bottom-up to top-down oscillation.

History of the Unconscious

The concepts of consciousness and unconscious influences originated in antiquity and have been contributed to by many different cultures. Hindu texts known as the Vedas (Alexander, 1990), Shakespeare (Faber, 1970), Paracelsus (Harms, 1967) and western philosophers such as Kierkegaard, Leibniz, Nietzsche and Spinoza have all contributed to the concept of the unconscious. One of the first psychologists to contribute substantially to the concept was Sigmund Freud. Freud was a clinical psychologist whose ideas about personal conflicts and the therapies necessary to treat them had a huge impact on the

psychology of his time and continues to influence modern clinical psychologists. One of the most seminal parts of Freudian psychology was his conception of the unconscious (he abandoned the currently unscientific term "subconscious" early on).

Freud proposed that every person came across thoughts that troubled and frustrated them. He believed that people often tried to suppress these unsettling thoughts and ideas and that usually these resided in the unconscious. When these thoughts became active again they most often did so without conscious action or knowledge. These suppressed cognitions, many of which were thought to be formed at a very young age, were related to socially unacceptable ideas or desires, jealousy, guilt, inadequacy and traumatic memories. Unconscious thoughts were not available to introspection but could be "tapped" by the use of dream analysis, free association or verbal slips and then "interpreted" by a therapist trained in psychoanalytic methods. Freud also coined the term preconscious which described thoughts which are currently unconscious though available for recall at anytime. One of his most popular conclusions about the unconscious is that it can be taken to represent a tremendous influence on thought and behavior and that the conscious mind is only the "tip of the iceberg."

John Searle in the "Rediscovery of the Mind" has written a critique of Freudian unconscious. Here he contends that "unconscious thoughts" are untenable constructs and that for thoughts to exist there must be a thinker. Loftus and Klinger have challenged this argument stating that such a thinker could exist silently, culminating in the idea of a dumb unconscious. In my opinion, if what the unconscious does is taken to constitute thinking it should be on a continuum with conscious thinking where unconscious

"thoughts" are more discrete, less reconciled with other thoughts and less lasting in the brain. It certainly would not if we were using the previous definition of thought: cyclical oscillations of information between imagery and association areas.

Contrasting Freud's view, modern psychology does not hold that the information that lies within the unconscious is necessarily repressed and it does not focus so closely on negative emotions. It simply posits that we do not have access to, notice or understand many of the processes underlying thought and behavior (Kihlstrom 1987). Much of Freud's work is still valuable to modern psychologists and therapists but psychology has changed much since his time. Much of Freud's work was based on speculation and observation but today's psychologists are more apt to favor orientations based around research and experimentation. Freud was opposed by critics claiming that his ideas about the unconscious were not falsifiable or scientific and this criticism still lingers.
Today, most research on unconscious processing is done in the academic tradition of the information processing paradigm and not Freud's psychodynamic one. Speculative concepts such as the Oedipus and Electra complexes, the death wish and the centrality of libidinous impulses are no longer thought to be useful and instead the cognitive tradition minimizes theoretical assumptions and rests on data-driven, empirical research. Even today though, nonscientists commonly use the concept of the unconscious haphazardly to discuss speculative, mystical or occult phenomena.

Prior to the '70s most formal psychological research failed to address unconscious or automatic processing as a scientific phenomenon. Since the 1970s a great number of psychologists have conducted studies to help define exactly what affect the unconscious

mind and its automatic processing have on behavior and mental processes. Subsequent work in the area developed a clear framework that carefully defines automatic processing and delves deeply into its implications on different aspects of psychology. Some see the unconscious mind as a limited metaphor that is not cohesive enough to be thoroughly refined. Neuroscientists are more apt to study unconscious processes than the more literary and psychoanalytic concept of the unconscious mind (Westen, 1998). For example, Timothy Wilson's idea of an adaptive unconscious describes unconscious processes that are not lowly and simple but that involve more complicated, even goal-directed activities. The modifier, adaptive, holds the connotation that the unconscious has been fine-tuned by evolution to respond to organismal and environmental concerns. Keeping these things in mind we will take a look at a few different forms of unconscious processing in order to better understand how they work.

Unconscious and Automatic Processing

Reminiscent of Freund's iceberg analogy, scientists today believe that a great deal of human behavior is affected by automatic processing. Automatic processing occurs anytime a person's behavior is influenced without them being consciously aware of it. This type of processing affects what we like, what we are uncomfortable with, what we are motivated by and how we act. It would seem very difficult at times to distinguish conscious from automatic processes. Experts largely agree though that unconscious, automatic processes can be associated with specific, distinguishing elements (Shiffrin and Schneider 1977). Automatic processes are those that 1) occur outside of awareness; 2) are very efficient in that they require very few cognitive resources and can be completed in

parallel with other processes; 3) they are uncontrollable in that they cannot be stopped or inhibited once they have been started and 4) they are never intentional. Finally, consciousness is often assessed with verbal reports whereas completely unconscious processes are unable to be perceived or reported upon verbally (Ericsson and Simon, 1993). Conscious processes are available globally (decentralized and distributed) so they can be easily directed toward the areas responsible for language and verbal imagery whereas unconscious processes are localized, have limited outputs to other areas, and information about their content cannot be directed to language areas. Thus, unconscious processes are insular, but at the same time very fast. In fact, the conscious mind is thought to be hundreds of milliseconds behind unconscious processes (Shiffrin and Schneider 1977).

Actions that involve automaticity do not require conscious control to be completed. The ability to learn or acquire these automatic processes though, often requires practice or trial and error. In fact, it is thought that all actions conscious or unconscious involve parallel processing which is found when the conscious and the unconscious are working in unison. Walking, driving a car and many other complex functions that necessitate practice involve such parallel or dual processing. It is now thought that very few, if any, high-order cognitive processes use one or the other exclusively (Bargh 1989, 1994; Zbrodoff and Logan 1986). Reading is a good example of dual processing because learning how to read takes a great deal of practice yet with time the difficulties involved in phonetics, spelling, and sentence recognition become second nature. After much practice one automatically delegates the technical aspects

involved in reading to the unconscious and can concentrate his or her conscious thought on the content of the writing. Studies have shown that many forms of motoric, perceptual and cognitive processing can become highly automatic through extensive practice (Underwood 1974).

It is not understood whether the unconscious can create new associations; whether it can take one concept, rationalize it and associate it to another without conscious awareness. This makes one wonder whether most associations, within the neural association areas, were at one time rationalized by the conscious. One might find themself trying to hurt someone that they have been consciously jealous of in the past without having to become consciously jealous of them again in the present. This points to the idea that the further an association has been elaborated upon in the past, the more conscious it can be taken to be in the present. The unconscious was programmed with certain motivations in mind, so when we use some of these old automatisms we have to ensure that the motivation or emotion that was there when it was created fits the current scenario, otherwise we might be planning behavior with unintended consequences.

Subliminal Perception

Stimuli that are never perceived by consciousness are able to profoundly affect behavior. This is known as subliminal perception. There are many ways to be exposed unconsciously to outside information without being aware of it. Information that is available for very brief periods or available among a lot of "noise" can be "hidden" from focused attention but still have access to the mind (Vokey and Read, 1985). Visual stimuli that are flashed on a screen very quickly can enter early visual cortex without

being processed sufficiently to reach consciousness. Visual stimuli can also be presented and then masked, thereby interrupting the processing. Auditory stimuli can be subliminal if they are played below an audible volume, masked by other stimuli or recorded backwards. Contrary to superliminal stimuli, these forms of subliminal stimuli are below an individual's absolute threshold for conscious perception.

Studies examining subliminal stimuli have shown that emotionally arousing pictures can be flashed on a screen for a duration too short for conscious attention to be directed to them. Nonetheless, early processing areas in the visual cortex begin to perceive this imagery and can send outputs to emotional areas increasing physiological arousal without awareness. The person that witnessed the shocking imagery might report that they feel shocked or uneasy but cannot explain why. Perception without awareness (Ortells, Juan et al, 2002) can influence many different types of behavioral consequences including complex decision making. The scientific literature on the phenomenon of priming explores the effects of stimuli that are consciously perceived but that affect behavior on an unconscious level because exposure to them has been forgotten.

Priming

Priming, or the implicit memory effect, takes place when superliminal exposure to a stimulus is forgotten about completely but still influences the response to a similar stimulus later. Word-stem completion tests are an excellent example. These demonstrate that if someone is shown a long list of words that includes the word misguided, they will be more likely to use the word when asked later to complete a word starting with the letters mis. Priming works best for stimuli within the same modality. This means that

visual priming works best with visual cues and verbal priming with verbal cues. But priming can also occur between modalities (Zurif, 1995). Priming can be perceptual (where tab primes table) or conceptual (where tab primes the word chair). Similarly fox can prime the recollection of the word wolf because of their perceptual resemblance. The word fox can also prime the adjective sly, conceivably because of their semantic or conceptual associations (Matsukawa et al., 2005). Multiple primed concepts have been shown to interact together to prime (or speed up processing of) an associated concept in what has been called context priming. This happens when one reads written text. The grammar and vocabulary of a sentence provide contextual cues for words that occur later in the sentence. These later words are processed more quickly than if they had been read alone (Stanovich & West, 1983).

Lexical decision tasks are interesting tests where participants are asked to quickly indicate whether a set if letters is a word or nonword (e.g., “fishing” versus “lishing”). It takes time and processing resources to determine if the word in known vocabulary. But there is a very easy way to speed this process up. These tests show that priming of a related word can increase reaction time. For example if you are shown the word “nurse” and asked if it is a word or nonword, your reaction would be faster if nurse was preceded by “doctor” than if it was preceded by “butter.” Showing people the word “water,” even minutes before, will speed up their recognition of drink as a valid word. This is interesting because since water activates the word drink, it also must activate many other similar words such as “pool,” “splash” and “wet.” This suggests that past associative linkages between concepts may cause us to have a predilection for activating a related

concept without having a conscious rationale. Interestingly, primed concepts have been shown to illogically effect decisions. In fact, completely uninformative, only nominally related stimuli can prime networks that result in illogically biased estimations and decisions and this is known as primed contamination (Chapman & Johnson, 2002).

Priming is thought to occur because the neural networks of closely related representations activate and disinhibit each other. The priming phenomenon is not conscious and is unstoppable, an artifact of neural architecture. There are two types of priming, positive and negative. Positive priming, which can occur even if the stimulus is not seen, speeds up the processing of a stimulus. It is thought to be caused by spreading activation where encountering a stimulus makes the representations of it in memory (and other closely associated representations) more active (Mayr & Buchner, 2007). This increased activity makes it so that a related task can fully activate this representation making it consciously accessible. Negative priming occurs when someone experiences a stimulus and chooses to ignore it. The act of ignoring something that is brought to mind makes it less accessible in the future (Reisberg, 2007). The distractor inhibition model asserts that ignored stimuli are actively inhibited in the brain (Mayr & Buchner, 2007).

Studies of patients with anterograde amnesia due to damage to the medial temporal lobe and hippocampus, show that patients retain the ability for perceptual priming and some abilities related to conceptual priming (Cermak et al., 1985). This indicates that the priming phenomenon is independent of the declarative memory system which is controlled by the medial temporal lobe and hippocampus. In the same way, the polypedal pattern of coactivation described in the last chapter is hippocampal

independent. For the most part, the dynamics of activation, coactivation and deactivation are driven by the same neural logic that underlies priming phenomena.

Priming and stimulus repetition improves performance and it also decreases neural processing in the cerebral cortex. Studies utilizing a number of different brain imaging techniques indicate that perceptual priming reduces processing (and the energy expenditure and bloodflow associated with it) in early sensory areas (Wig et al., 2005). This is probably because earlier activation sharpens representational networks reducing the efforts needed to reactivate these networks. Conceptual priming has been linked to reduced blood flow in the prefrontal cortex, indicating that its involvement in the semantic processing of words is reduced by prior exposure (Demb et al., 1995). That a fundamental part of the process of conceptual priming, a largely unconscious phenomenon, takes place in the PFC demonstrates that the involvement of the PFC and other association areas does not ensure attention, awareness or consciousness.

Unconsciousness, Processing Resources and Habit

Concepts in the brain can become interrelated and they can maintain their closeness even when the reason that they have been paired is no longer able to be recalled by the conscious mind. We do our learning by associating new concepts to old ones, or old concepts to old ones in new ways. Concept pairings that are rationalized or used routinely are often taken as knowledge, beliefs or mental schemas. When we make associations with our conscious mind, the brain changes physically, neuronal pathways between associated nodes become more used and therefore more accessible. I have called

this gradual process “implicitization” and this is one way for processes to become unconscious.

Our behavior in any situation can be thought of as mostly a patch-work of different responses that we have in our repertoire that are inflexibly and somewhat arbitrarily applied in our everyday activities. At one point, these behaviors (especially when they were first conceived, thought through or imitated) were open to analysis, insight and change. Over time, the behaviors became closed off to new information, to introspection and even to consciousness. After a behavior or a reaction or a tendency or a frame of mind has been open to consciousness, it transitions toward becoming unconscious. The pathways in the brain become more and more ingrained. The psychological avenues in the brain become more and more familiar to us, more trusted because they have proven effective, or at least not harmful. A temporary solution becomes a tendency, becomes a habit, becomes a way of life.

This automation of learned behaviors can be highly beneficial because it allows us to use our limited processing resources to attend to other, incipient behaviors and allows us to pool together a number of automated activities to accomplish more complex, conglomerated activities. The down side of this is that sometimes we have a tendency to put automated activities together in ways that they were not meant to be combined and this can lead to confused behavior, mistakes and even misinformed thought. We combine these automatisms according to instinct, impulse, intuition and, probably to a more limited extent, reason.

So the fact that much of our behavior is a patchwork of inflexible actions is good thing; however, it can be bad if we have little insight into how we are sewing the patches together. But would it be helpful to question our driving route at each and every intersection? When we stop questioning ourselves and the applicability of our actions it is very easy to fall into entrenched routines. After years of driving, heavy traffic or a major obstruction on our favorite route won't deter us, we are willing to wait it out instead of expending the mental energy and exercising the mental discipline it takes to devise an alternate path. What we think now and how we allowed ourselves to think in the past is going to affect our ability to make decisions in the future. If the thoroughfares that are being employed are not numerous, pertinent or well-functioning, behavioral complexity and functionality can be expected to decline. The less variability we seek, the less new knowledge we procure and the less we try to adjust our behavior to closely account for small variations in our environment the simpler our behavior becomes.

Becoming conscious of a distinct association between two things happens when a particular association between two concepts is coactivated with other associations. Together these coactivates create imagery in early sensory areas that depicts some kind of interaction between the associated concepts. This imagery is reappraised by association areas, which maintain the two concepts as coactivates but adds new ones, which are sent back to early sensory areas to create more imagery and so on. In other words, the longer the cortical octopus holds two concepts in its embrace during alternating cycles of imagery and reperception, the more the relationship between those two concepts will become conscious. Ironically, the more closely associated these two concepts come to be,

the more their imagined aspects become chunked together and the more the association between them is an implicit assumption in subsequent bouts of coactivation.

Conclusions

We have considered here that perhaps the unconscious is not an entity, separate from consciousness, meant to be anthropomorphized. It is part of our mental tool set, part of the wiring of the brain, involved in the simplification of physical action, memory recall, motivation, and other behavior. This review has allowed us to form some general conclusions about how unconscious or automatic effects operate:

1) It is not necessary to be aware of incoming information for it to affect performance

2) automatic processing, unlike controlled processing, cannot be reported about verbally

3) automatic activity involves activation that is too transient to be noticed or recalled

4) automatic activity involves activation in an area that either does not communicate appreciably to the PFC, or at least the PFC has not been tuned to recognize its communications

5) perhaps conscious activity is generally composed of the same types of processes as unconscious activity, only conscious activity is temporally prolonged

This discussion of unconscious processes may have a powerful bearing on how beliefs are formed and how they can go wrong. Many of the mistakes of belief formation involve a mix of conscious and unconscious thinking-gone-wrong. The true cognitive factors involved in belief determination may be relatively cognitively impenetrable to many because they involve implicit assumptions that go mostly unnoticed. Certain aspects of belief evaluation probably become automated over time until a point is reached

where it is very difficult to have introspective insight into a process that illusorily appears conscious and deliberate. But even early beliefs are probably muddled and disarrayed. The first beliefs, formed in early childhood, must come about without being scrutinized rationally or explicitly. An infant does not have the capacity to search for justification for its beliefs, a process that probably involves life experience and even proficiency with language. This tells us that, as infants grow older, they probably implicitly maintain some of their criteria (which was never exposed to declarative criticism) for accepting beliefs. Infants certainly form strong expectations and attitudes - two processes that appear very much like beliefs. But how do they do this? Looking at beliefs ontogenetically, blurs the line between beliefs and attitudes. Looking at beliefs from the perspective of unconscious processing, blurs the line between implicit and explicit belief.

The neuroscience or neuropsychology of belief is a contentious topic. Some researchers have argued that beliefs must be represented in the mind by consistent, recognizable patterns of neural activity, whereas others have argued that scientists should not expect there to be a coherent neurological substrate or physical embodiment of a belief. To explore this, we must first concede that although beliefs must be physical phenomena and that different beliefs must share some neurological similarities, they are not unitary. There must be several types of beliefs and to some degree every belief must have a different physical, or neuroanatomical makeup. This literature review has pointed out that there are accepted beliefs, rejected beliefs and beliefs that are in the process of being entertained or tried-out. Such “candidate beliefs,” that might be held in suspended disbelief, would probably have a different basis in the brain than a belief that is firmly

entrenched in the psyche. New beliefs are usually more tentative whereas the oldest beliefs are unlikely to be overturned easily because of emotional and implicit factors that are difficult to overcome. The neural "networks" that correspond to personally important, long-held beliefs must involve extensive, wiry masses of neurons and axons that branch out and interact with sensory, language and even subcortical systems. On the other hand, a short-lived belief may only amount to a small number of synaptic changes in temporal or prefrontal cortex. Because beliefs come in so many different flavors, one would assume that they each must have different neural bases. We certainly wouldn't expect the following types of beliefs to involve the same neuroanatomical infrastructure: uncertain beliefs, religious beliefs, beliefs about motor praxis, superstitious beliefs, implied beliefs, well-contemplated beliefs, common misconceptions, dogmatic beliefs, iconoclastic beliefs, make-beliefs, self-serving beliefs, self-defeating beliefs, etc. Neuroscience does not nearly seem to be ready to attempt to reduce belief from the mysterious, personal experience that we all know, to the cooperation and interactions of the molecules that build and organize neurons, their circuits and their emergent mental processes.

We can no longer blame the "malicious" unconscious mind for stereotyping individuals against our wishes. We must blame the reemergence of associations that we made hyperaccessible in the past for this automatic stereotyping. When we dance we can no longer attribute the complex movements which seem so "natural" yet so intricate to the dexterity of the conscious mind. We should attribute this to the many complex memories for movement that we have created within our brain and spine throughout our lives. The unconscious is not a mind, is not an entity and anthropomorphizing it using

human adjectives may be fun but is misleading. Or is it? Is it equally as anthropomorphic to attribute beliefs and other high-order cognitive states to our conscious mind?

When I was very young, the material I read about the unconscious led me to believe that it was a mysterious and intelligent entity that connived and planned with foresight and its own set of goals. After reading the psychological literature about unconscious processes more recently, I have come to see them as inadvertent reflexes, misunderstood impulses, and generally just a side effect of the way memory interacts with consciousness. The unconscious is more a series of discrete, unrelated processes than anything that has the cohesion and sophistication to be comparable to consciousness. To me, this illusion of an unconscious entity dissipated to become no longer a mind, no longer another entity that shares my head. However, another major theme that has emerged in this discourse is the piecemail, fragmentary, irrational, unsystematic, unreliable nature of conscious processes. Many studies have shown that we are just a bundle of instincts and impulses and that there is often very little true continuity even in our conscious lives. These findings along with things like the cohesiveness and meaningfulness of my dreams, my Freudian slips and my intuition has urged me to reconsider. Perhaps if I am going to consider my consciousness to constitute a mind despite the fact that it is insubstantial in many ways, then it is only fair to permit unconsciousness the same nominal privilege. Withholding this distinction from unconsciousness could be considered existential hypocrisy.

How can we pursue distinctions between conscious and unconscious processes if conscious processes are actually composed of unconscious ones as discussed above?

Earlier I argued that temporal persistence of unconscious processes creates consciousness. Unconscious, associative linkages are responsible for priming all of the things that come to consciousness and unconscious motivational-neurons in the subcortex decide to keep these things primed. “We” don’t pick and choose our associations or motivations, we can inhibit some, but the rationale for this inhibition was, again, summoned unintentionally by associative networks. Remember, when you coactivate a number of different features, concepts that you could never anticipate, or even summon voluntarily, are invoked.

The unconscious allows the conscious mind to skip from conception A to conception C when it used to have to go through B first. A is now sufficient to pull up C by itself and B is habituated to. In most cases B can be recalled declaratively (meaning it is preconscious), but is implicit in the process of moving from A to C. In terms of the octopus we introduced in the last chapter, B is a module that can be left out entirely from the coactivation process and the modules that comprise A can activate module C on their own. Thus, a module becomes implicit, and its features become unconscious, when it is no longer needed - during coactivation with its normal coactivates - to recruit another particular module. In this way, the octopus of consciousness is constantly obviating the need for modules.

Chapter 11: Natural Selection and Belief

"Nothing in biology makes sense except in the light of evolution."
-Theodosius Dobzhansky

Weak points in our abilities to formulate realistic beliefs may have genetic, biological bases that have their origins in evolution. It is clear that we were naturally selected to think clearly about and ponder certain things but these probably did not involve the same types of concepts or activities that we contemplate today (Nesse & Williams, 1995). Today our beliefs rarely involve foraging, ranging, tracking, food processing, hunting, protection from the elements or from predators; the concepts that we were designed to test, systemize and understand (Cosmides & Tooby, 1992). Natural selection may not have ever been responsible for selecting us to formulate functional beliefs about philosophical, sociological, religious and scientific concepts. We were never selected on the basis of our ability to have epistemologically sound, high-order beliefs. Much of the thinking done by our ancestors, even the higher-order thinking, probably controlled procedural processes - the capacity to learn, store and recall information about physical tasks and movements. When we use the same brains used to forage and hunt to contemplate academic phenomena with complex natural backgrounds we are liable to make errors. It is a little disconcerting, given the extent of human dominion over the earth, that we may not be well-adapted to contemplating and forming opinions about modern issues.

In the ancestral past, humans were selected to respond to physical feedback from the environment as to whether the plan of action that they chose was efficacious or not.

Today, our activities involve topics that are difficult to test by ourselves because we do not get the same instant physical feedback from them. Few of our beliefs involve survival or even true behavior; more often they simply involve further thought. Since many of our beliefs are about intangible or abstract concepts, and because they often do not translate into behavior, we probably get less feedback from the environment about the accuracy of our beliefs than we used to. Further, the dangers of prehistoric environments may have selected us to unhesitatingly choose one belief over another without concerted deliberation. Unfortunately this pressure to react quickly may lead us to be hasty, especially with stressful or emotionally arousing beliefs. In other words, beliefs about issues that are the most important may be formed rapidly because the brain is tricked into thinking that there is limited time due to portending danger.

The brain that we inherited from our reptilian and "paleomammalian" ancestors was designed to process procedural and emotional behaviors. These types of memory had much more time to develop evolutionarily than did declarative memory. Moreover, procedural and emotional expertise is gained easily and rapidly and leaves little room for mistakes. Coordinating suitable movements and properly assessing danger is much less error-prone than forming accurate beliefs about abstract topics. Expertise with language-driven belief making is hard-won and still much more susceptible to error and miscalculation.

Everyone knows the feeling of being assured and confident in a specific statement. It seems that evolution endowed us with a sensation of surety, a "feeling of being certain." In order to feel this certainty we must be fairly sure about the belief in

question (Burton, 2008). Evolution must have contributed to the set point of how easy it is to have this feeling of certainty. Today this may cause us to accept beliefs that sound right but are factually inaccurate, and because they are not testable, this leads us to an increased proclivity for believing the wrong stuff. Evolutionary shortcuts, the inability to ensure that our beliefs are systematic and the reliance of our beliefs on a faulty memory system have rendered us rather gullible and susceptible to the influence of minutiae that we may not even vaguely be aware of. The manner in which natural selection fine-tuned us to believe may involve a mismatch between the environment that our brains are expecting and the 21st century environment that they are experiencing.

Chapter 12: Déjà vu, Emotion and False Feelings of Certainty

"You got to be careful if you don't know where you're going, because you might not get there."
- Yogi Berra

Déjà vu is the experience of a new situation that feels like it has been previously witnessed or experienced. I think that my theoretical explanation for the phenomenon sheds light on the experience of belief certainty, so I will share it here. I argue that the feeling of déjà vu is a delusion created by the coactivation of several memories each corresponding to familiar features that the person has experienced before. These features have truly been experienced before, but never all together. People are always experiencing features that they have seen elsewhere, but when enough of these features come together during one experience, the person may have a strong feeling that they have done this thing before- and this feeling is usually correct. Sometimes this feeling is wrong. When it is wrong it results in déjà vu and this is probably related to the false alarm principle. Alarms, like human minds, are calibrated to detect coincidences. Usually the presence of a large number of smoke molecules within the internal detection chamber of a fire alarm indicates to the alarm that something is burning. In the same sense, a large number of familiar coactivations must tell some neurological module, responsible for coincidence detection, that it should invoke the mental sensation of having “already seen” the present experience. Like the alarm, this module is calibrated to minimize error, but more importantly, to maximize detection. A false alarm for a fire is usually not costly, but an undetected fire can be tremendously costly. In the same sense, the experience of déjà

vu may not be costly to reproductive success, but failing to integrate a set of important behavioral cues certainly might be. It seems that this coincidence detection module in the brain works relatively well because déjà vu, although common, is very infrequent.

The human brain must also be equipped with a belief certainty detector module that tells us that a sufficient amount of rationale and evidence seems to have been compiled to justify the feeling of certainty. This module must be innate because everyone seems to have it, but it also must be programmed or calibrated by environment learning. Trial and error teach us when it is safe to feel certain and when it is not. By childhood, this detector works very well for simple physical and social activities. Most children can be around a new person for a few minutes and gauge how safe or hostile this person is. Different features of hostility or amiability combine to create an overall impression and if the amiability greatly overwhelms the hostility the child might feel certain that the person is safe. A child might feel certain that a building of blocks is stable enough not to topple, or elaborate enough to engender praise from their parent. Despite how certain the child feels this, the certainty could be delusive.

In adulthood this detector (and especially its inputs) becomes much more experienced and reliable for use with complex situations. It is still possible though, for an adult to feel quite certain about a belief even though the belief is false. This is probably most common when it takes place in an area that the person is inexperienced in. Especially in an unfamiliar domain, the certainty module is likely to misfire when a number of contributing criteria indicate that the person should feel certain even though they should not, and even though the criteria are misleading. For instance, a social worker

not accustomed to dealing with convicted criminals might fully believe that a client is trustworthy even when they are not. Further, a person might feel that they have all of the rationale in the world to be convinced conclusively in the existence of free will even though this stance may not currently be philosophically or scientifically tenable. As we said about beliefs earlier, this belief module may have its own logic that is not accessible to consciousness. The feeling of certainty (like déjà vu, anger, excitement and other emotions), however, is accessible to consciousness and feels authoritative and dependable.

It feels good to be able to come to a conclusion about the veracity or falsity of a premise and it feels bad to remain uncertain. We are probably given satisfaction by our pleasure and reward systems for thinking a problem through to the point where we feel we have satisfied the necessary epistemological demands of certitude. The environment must interact with some, currently unknown, neurological system to calibrate this scale between truthfulness and falseness. A very precise scale of weight only shows that two things are equal in weight when both weight the exact same amount. The antecedents that contribute to the mental scales of certainty though, (measuring the difference between the truthfulness and the falseness of a proposition) are rarely precisely measured, and thus, most people rarely judge truth and falseness equal and decide to be uncertain. Our scales for certainty are usually tipped one way or another because balance or uncertainty is an aversive state. One side usually weighs more and largely our emotional system ultimately makes the determination that this option “must be right.” That we are emotionally programmed to loathe the feeling of uncertainty may explain why we often “have to

know," why we believe resolutely in mere hypotheses and why aboriginal cultures (and industrialized nations) necessitate "just so stories" to explain the origins of humans and the creation of the universe.

There is an intriguing body of literature on the therapeutic benefits of the appraisal of emotions. This clinical research – often related to cognitive behavioral therapy or mindfulness meditation - shows that negative emotions can be quelled and controlled simply by identifying them (Hofmann et al., 2010). When a person is able to recognize a negative emotion like sadness or frustration, certain areas of the PFC become active and reframe the feeling from a compelling sensation to a harmless concept reducing its negative emotional impact (Kabat-Zinn, 2005). The negative, misleading aspects of the emotion of certainty might also be ameliorated from similar appraisals. Identifying feelings of certainty as the fallible approximations that they are may help people to dissociate from dangerously subjective opinions. The simple act of appraising felt certainty as mere belief should help people to question unsupported assumptions and foster objectivity.

The feeling of certainty, like other feelings, arises from involuntary sensory systems that are highly fallible but have been tuned by both evolution and the environment to help us make up our mind. No isolated circuitry in the human brain can think without input from emotional, involuntary and undetectable influences. Even though certainty can feel very much like a conscious conclusion that we reach purposefully and intentionally, certainty is often a mental sensation that happens mechanistically, deterministically and preattentively.

Chapter 13: Other People's Beliefs

"It is the mark of an educated mind to be able to entertain a thought without accepting it."
-Aristotle

As with other forms of learning it seems that learning what to believe starts with adopting or modeling the beliefs of others. Understanding how others introduce us to beliefs and how we conceptualize them in an ontogenetic sense should prove integral to understanding not only how beliefs develop but also how they change with time. James Alcock famously argued that our beliefs have their origins in the influences of authority figures; specifically pinpointing parents as the main influence for most people early in life (Alcock, 1995). Authority figures may also, according to Alcock, influence one's "gut feelings" because, at a young age, one does not necessarily have sufficient empirical evidence to support his or her beliefs (Alcock, 1981). Literature on the development of social theories supports the idea that children primarily adopt beliefs from parents, peers, teachers and other social agents and then create a larger proportion of their own beliefs later in life as experiences accumulate (Alcock et al., 1998; Anderson & Sechler, 1986). Beliefs adopted or borrowed during childhood and adolescence create scaffolding for personal belief building in adulthood. In young childhood, when many core beliefs are first being formulated, children actively learn about what to believe and how to believe from their parents, teachers and friends. Many of these early beliefs are formative and resistant to change (Anderson & Sechler, 1986). These findings and others like them may also indicate that beliefs that have emotional concomitants, like many religious and sociological beliefs, have a tendency to become fixed early in life for the same complex

reasons that emotional responses and personality become fixed early on. One survey study has shown that people, regardless of age, have a strong tendency to believe in the religion that they were inculcated into during childhood (Argyle, 1997). In the book, Parental Belief Systems: The Psychological Consequences for Children, Irving Sigel claimed that belief systems should change with respect to parents' influences over time. He pointed out that if one were to measure similarities in the beliefs of parents and children, it would be important to note how old the children are during the time of the study. Survey and interview-based research has found that young children tend to blindly accept whatever their parents tell them, and may never question these beliefs or even have a full understanding of them (Sigel, 1992). By the time they reach adolescence, they tend to be more rebellious and may want to distance themselves from their parents, in which case they may form their own beliefs and reject the stances taken by their parents. Once individuals reach young adulthood, the similarities in beliefs become less predictable.

David A. Murphey's (1992) research has shown that children are highly likely to adopt the beliefs of people they find charismatic, interesting and inspiring. He points out that the parents that are most successful in effectively transferring their heartfelt belief systems are those that are accepted by their children as role models. Charismatic and loving parents that avoid inciting dissent, seem to be the most influential. Similarly, a longitudinal, questionnaire-based study performed by Allan Wigfield (1994) revealed that the more involved a parent is and the more they combine warmth with reasonable levels of control, the more likely their child is to share their general attitudes and beliefs about

the world. Interestingly, parenting style has been shown to be highly conserved across generations (Simons et al., 1992).

Religious affiliation provides a set of core beliefs that have been proven predictable, in some ways, to psychologists (Argyle, 2000). Scott Myers of Penn State University published one study examining the heredity of religious beliefs in 1996. The study, which interviewed 471 parents and their adult offspring, attempted to determine the degree to which parental religious beliefs affect their child's chosen religion. The study also attempted to identify some family characteristics that make intergenerational transmission of religious beliefs more likely. The study found that the children's religious beliefs were strongly correlated with the beliefs of their parents. The study also found that religious beliefs are particularly similar amongst close-knit families in which the mother did not work (Myers, 1996). Previous work conducted by Cynthia Clark and colleagues (1988) looking at transmission of religious beliefs to first-born sons resulted in somewhat similar findings. This work featured 68 mother-father-son triads, where each family member was interviewed about their beliefs. The study incorporated and controlled a large number of potential predictors. Mothers were found to influence son's religious application and practice; whereas, fathers influenced son's church attendance. The authors point out that parents hope to transmit values to their children that are not interfered with by transmission from schools, media and other adolescents. They imply that this is not always easy. The findings also suggested that parents that served as dedicated, consistent role models were the most influential.

It seems that it is difficult to be an effective role model if your actions hypocritically contradict your verbal messages. In a study featuring 192 mother-adolescent pairs, there was a strong correlation between a mother's smoking-related beliefs and the likelihood that her child becomes a smoker (Chasin et al., 1998). However, the strongest predictor of whether a child will smoke was whether the mother herself smoked, suggesting that parental actions have a larger impact on children than beliefs do.

Another important set of beliefs that have been examined across generations are political beliefs. A study consisting of 1,440 college students asked to present their political beliefs and to estimate the beliefs of their parents showed that nearly two-fifths of the participating students rebelled actively against their parents' political beliefs (Middleton & Putney, 1963). Rebellious students tended to hold more liberal beliefs than their parents did and tended to report far more interest and involvement in politics than the students who mirrored their parents' political views.

A questionnaire study performed in 1983 by Allan Wigfield calculated correlations between a child's belief in their mathematical abilities and the child's perceptions of their parents' belief about them. His analyses caused him to conclude that the actual beliefs of parents do not have powerful, direct influences on children's beliefs. Instead children interpret whatever messages they receive from their parents (which may not necessarily coincide with the true beliefs of the parent), and these interpretations influence the child's beliefs (Wigfield, 1994). He concluded that the study demonstrates that parents' beliefs affect their children far less than the direct, explicit messages that

they provide, regardless of how few or how many. This is probably true for most beliefs, not just those transferred by parents. Children and adults should be more aware of this disseverance between true beliefs and communicated messages so that they can better monitor both the way that they construct their own messages and the way they think about the messages of others.

Sara Harkness (1997) wrote about the importance of cultural factors on parent's influence on beliefs. She discusses the case of second-generation immigrants and of how they struggle with the clashing between their parent's traditional views and those of the culture that they were born into and immersed in. Her studies have found that, although they often maintain that they respect their parents' belief systems, these people tend to favor the views of the culture into which they have been indoctrinated. People also tend to favor culture when their parents, families or friends have beliefs that can be taken by others to be superstitious, old-fashioned or insular (Harkness, 1997).

Attitudes and beliefs are known to be transmissible from parent to child but it is not known if this due to imitation or genetics (Underbill, 1988). We know that nurture effects attitudes and beliefs, but what about nature? Hereditary variables are thought to affect attitudes, but probably do so indirectly (Tesser, 1993). For example, if a person inherits a disposition to become an introvert, this may also indirectly affect their attitude towards other people, towards music or towards taste in apparel. Interestingly, the same principle may apply for beliefs. For example, a person with a genetic disposition for introversion may be more likely to believe that approaching strangers is dangerous. It would be interesting to employ twin studies (comparing beliefs between identical and

fraternal twins) to determine the contribution of environment and genetics to belief although many methodological issues may arise. There has been little study of innate, heritable beliefs but it is clear that most people believe that a meal of food is satisfying, that healthy mates are preferable and that kin and offspring are worth making some sacrifices for.

The discipline of evolutionary psychology looks at these kinds of common psychological traits and interprets them as adaptations to the ancestral, hunting and gathering environment (Cosmides & Tooby, 1992). Evolutionary psychologists interpret behaviors that are near universal, such as the predisposition to fear snakes and insects, to reflect the experiences of our ancestors (Bjorkland & Pelligrini, 2000). The role of natural selection in belief is uncertain. Although it is certain that our brains and nervous systems have preexisting pathways that strongly influence how we respond to our culture and environment. Further, some seemingly innate behaviors are not universal among humans, and these may correspond to particular alleles of a certain gene. For instance, people that are extroverted- due to certain genes diminishing the responsiveness of their amygdale, locus coeruleus, paraventricular hypothalamus or adrenal glands- may be more likely to espouse the belief that strangers are trustworthy and that people are inherently good. Thus, there are pathways through which genes could affect belief and these are generally congruent with the hypothesized pathways thought to exist for the heritability of attitudes (Tesser, 1993).

Another twist on the parental impact on belief is the viewpoint taken by physical anthropologists that refer to it as “intergenerational resource flows of cognitive capital

(Lancaster, 1997).” It takes resources, such as time and energy, to instruct offspring; resources that are that better spent elsewhere in most animal species. Human mothers, and often fathers, in hunter-gatherer groups instruct their young for nearly two full decades (Blurton Jones & Marlowe, 1999). This is done to ensure that the youth has the knowledge- about foraging, about social conventions and about survival- that it needs to survive and pass on its genes (Kaplan et al., 2000). Humans are unique in this regard. Virtually no other animals – even great apes - instruct their offspring for more than a decade. Thus, human brains may have evolved, within this didactic environment, to be neurologically suited for belief acquisition more than any other animal (Reser, 2006).

Richard Dawkins (1976) conceived individual units of this cultural information as self-propagating entities he calls memes. Dawkins defines a meme as an idea, practice or belief that can be transmitted from one mind to another through speech, writing, gestures or other imitable phenomena. Dawkins and other supporters of the meme concept regard memes as analogous to genes in that they self-replicate and respond to natural selection. For instance, memes are inherited from parent to child, memes mutate and change as they are passed along and only useful, or seemingly useful memes spread. Some memes become extinct and others, that replicate effectively- like religions, catch-phrases and dance movements- proliferate, even sometimes to the detriment of their host. Dawkins (1976) has said that memes can be thought to parasites the brains of their host and this has been called “thought contagion.” The meme concept and the accompanying discipline of memetics continues to be an influential, reductionist account of beliefs that shows us that beliefs can be envisioned as active replicators that invade and inhabit our passive

nervous systems. It also shows us that perhaps we have less control over the beliefs we find ourselves entertaining than we would like to think.

It is known that adults, in addition to children, tend to internalize the beliefs of the people that they are surrounded by. Beliefs espoused by one's community group, place of work, church, neighborhood, city or country often have powerful, polarizing effects on people. For instance, a neighborhood-based survey study found that one's political beliefs are effected the most by the political views in the community where one lives (Gelman et al., 2008). Studies like these make the process of believing seem quite deterministic. Some have questioned whether belief is voluntary or just a product of memes and the social environment. Like so many other psychological phenomena, the conclusion is generally that it can be either or both (Kida, 2006). As is thought to be the case for free will, it is clear that with beliefs the environment plays a significant role in a person's choices but it does not necessarily play the only role. In addition, certain environments can be more influential than others can, and certain people may be better able to exercise control and determination over their environmental inputs.

An instance where belief formation seems to be the most deterministic is when someone adopts the beliefs of a charismatic leader, even if the beliefs are contrary to their prior beliefs and even if the belief produces consequences detrimental to their self-interest (Hoffer, 2002). This phenomenon seems like it would be rare but has been documented to be a commonly occurring political and sociological phenomenon (Kida, 2006). Authoritative and especially authoritarian leaders have demonstrated this power many times during history. In fact, the pressure to be obedient to an authority, even when

it involves following untoward orders, has the capacity to modify beliefs profoundly (Blass, 1999). In other words, people change their beliefs to fit the expectations put on them by their environment, often doing so in ways that minimize cognitive dissonance or social reproach. Charisma, persuasiveness and frequency all play major factors in beliefs formed under pressure from others (Hoffer, 2002).

Scientists, technical specialists and other professional investigators are thought to have the capacity to influence and change the beliefs of the abecedarian. It is not currently known when or why people take the word of such experts on faith, but the appeal to scientific authority is extremely common. When one judges that they do not have the knowledge to model a belief correctly, they often turn to someone that does. One reason that people believe authorities is because they assume that the authority has considered more evidence. In this way, looking to an authority can be seen as a strategy for obtaining lots of evidence without having to search for it or organize it. Thomas Kuhn (1970) proposed that to evaluate the correctness of a scientific belief one must assess the assent of the scientific community, not merely the amount of supporting empirical evidence for the belief. This could be due to the fact that a layperson does not have the knowledge or expertise to judge the relative importance of the available evidence. The scientific community may adopt some beliefs because they deem the evidence for it to be particularly convincing despite the fact that it might appear scant or unconvincing to a novice. For example, the theory of evolution seemed outlandish to many of Darwin's contemporaries but to modern biologists, who have a much wider breadth of knowledge about biology, evolution is a logical necessity. Authorities are not always right and even

when they are it is not clear that their conclusions will be informative or helpful to laypeople in their day-to-day lives. It is fortunate that the opinions of authorities, on a multitude of important issues, are largely available to people willing to do a little research and reading although it is disappointing that few are willing to invest the time necessary to do it.

Other people, whether through their spoken or written communications, do much to influence our beliefs. Parents seem to be the biggest factor, especially in early life, and because their influence is formative, it is also lasting. We have seen that charisma, kindness, authority, expertise, frequency and cultural morays all act as contributory social influences on belief. Uncovering more about how beliefs are guided in the early years, and what influences these beliefs to be maintained should help inform scholastic and pedagogical efforts. In the next section, we will consider how other people's assessments of us, and our thoughts about this, can influence our beliefs.

Chapter 14: Importance to Self-identity

"I can believe anything provided it is incredible."
-Oscar Wilde

Abelson and Prentice (1989) maintained that beliefs interact extensively with self-identity concerns. They emphasized that beliefs help us to make decisions and solve problems in our own idiosyncratic ways - ways that help to define our social identity. Beliefs serve as identifiers and we use them to align ourselves with social groups and to advertise our central values and attitudes. It has been argued that extreme stands in an attitude are commonly a result of high ego-involvement (Levy, 1997). If a statement concerns a construct that contributes to a person's pride, uniqueness or self-identity, it will rarely be regarded with detachment and will usually arouse intense attitude.

Beliefs that are strongly tied to one's self-identity can be extremely difficult to change. Since our beliefs can do much to define us as individuals, we often defend them when they are questioned. Instead of changing our beliefs to fit with encountered evidence or subjecting them to criticism, we often protect them with defense mechanisms. People strive to maintain their sense of self-identity for many reasons: it gives them pride, a feeling of individuality and gives them a stable view of the world (Markus, 1977).

Information consistent with one's self-identity is seen by most people as more credible than information that is inconsistent (Levy, 1997). Self-concept maintenance results in the reinforcement of one's character, and causes people to try to reject feedback

that conflicts with their ideas about themselves (Sutherland, 1992). People will go to great lengths to maintain their sense of identity. They will engage in certain cognitive strategies (that can be largely unconscious) that include selective attention, selective memory, and selective interpretation (Shermer, 2003). Furthermore, consonant with the elaboration likelihood model discussed below, statements that arouse polarized attitudes are likely to have been evaluated heavily in the past and will be more stable (Sherif & Sherif, 1968). It is clear that the desire to keep our beliefs in line with our self-concept determines what kind of feedback we seek from others and from our environment (Gilovich, 1990). At times it may not be clear if people are more concerned about believing things that are true or about believing things consistent with egoic concerns. Also, things that involve pride, vanity or self-worth, often also involve the types of emotion that can cloud judgment.

Self-identity causes us to espouse beliefs that cohere with our values without respect to fact. For example, someone who considers themselves an environmentalist might believe that all re-cycling activities, natural alternative energy sources and forms of conservation are good and that all materialism, waste and pollution should be avoided at any cost. This tendency to align with a cause and to reject anything that, at first glance, appears inconsistent with the cause is a common strategy used by people with ties to a political party, religion, secular initiative, philosophical movement or strong personal conviction. Especially in domains such as politics, there is often so much information about the issues that people are forced to choose sides based on slogans or catchwords instead of knowledge building. Unlike knowledge systems, belief systems can tend to

hold conceptions that cluster together based on specious or frivolous assumptions. Knowledge systems are formed logically and objectively whereas belief systems are formed in whatever way the believer sees fit at the time. All of this points back to the existence of central beliefs, which are often egocentric and which spawn derivative beliefs in a quasi-rational fashion (Abelson, 1979).

An article by Castelfranchi (1996) offered a substantial review of the literature on self-concept and concluded by suggesting three measures of self-identity: relevance, permanence and likeability. Castelfranchi argued that these three constructs are the main emotional determinants that guide us through the process of accepting or rejecting beliefs and that they ultimately contribute strongly to certainty. Changes in the relative permanence, likeability and relevance are thought to predict swift changes in belief strength (Castelfranchi, 1996) and further underscore the role of self-identity concerns in belief formation. Research shows that these three measures fluctuate with respect to one another, depending on the belief in question. Questionnaire studies performed by the present author indicate that permanence is often rated highly by experimental subjects faced with beliefs that relate to self-image. Likeability has been shown to be similarly related to attitude, as has relevance to lifestyle (Reser, 2009).

Evidence also points toward the fact that our beliefs and attitudes are often determined by past behavior. When our past behavior does not coincide with our beliefs, an aversive state of "cognitive dissonance" arises forcing us to reappraise our beliefs in terms of who we are and what we have done in the past (Festinger & Carlsmith, 1959). People will often accept beliefs that they feel they have a vested interest in. They will be

more likely to believe things that are consistent with their lifestyle or in-line with their political leanings (Taber & Milton, 2006). People can probably have a cognitive vested interest in certain leanings as well. If past thinking is generally inconsistent with a new belief it can serve as a barrier to entry for the belief. Some people remain open to new ideas and this "cognitive liquidity" can be beneficial or subversive depending on how conscientiously and prudently it is used. Bem's (1967) self perception theory and Gazzaniga's (1998) interpreter theory echo this sentiment and reinforce the notion that people, sometimes unwittingly, search for reasons to side with previous decisions.

Chapter 15: Attitude Change, Persuasion and Belief

"The Church says that the Earth is flat, but I know that it is round. For I have seen the shadow on the moon and I have more faith in the Shadow than in the Church."
- Ferdinand Magellan

Attitudes represent a major construct with a heavy bearing on beliefs that modern psychology has given a full treatment. This literature shows that not all human judgments can be assessed as either veridically wrong or right. Attitudes, unlike beliefs cannot be false or delusional in an objective sense, but like beliefs, are sentiments that are frequently held with conviction. An attitude is a hypothetical construct that represents a person's measure of like or dislike for something (Eagly & Chaiken, 1995). Attitudes are thought to represent stable, learned predispositions to respond to a stimulus in a fixed way. Beliefs often tend to be more cognitive and attitudes tend to be more affective and conative in the sense that they involve motivated reactions to the environment. Like beliefs, attitudes are formed either from observational learning or through direct experience (Fazio, 1986). Due to the similarities between attitudes and beliefs, we will take some time surveying the popular literature on attitudes to see how they form and change and to see how they overlap with beliefs. Happily, research on how attitudes form has been a topic of a great deal of purposeful research.

Because of the similarities that they share, attitudes have been said to be congruent with but not necessarily equal to beliefs (Underhill, 1988). Some researchers argue that beliefs are a type of attitude, and others contend that the two represent opposite ends of a spectrum (Bassarear, 1989). More recently, like beliefs, attitudes have been

characterized as being impacted by conscious and unconscious factors and subject to continuous evaluation and change (Furinghetti & Pehkonen, 2002). Generally attitudes are either positive or negative but they can be ambivalent or conflicted such as when someone holds a positive and negative attitude toward an item simultaneously. A person can hold conflicting or mutually incompatible beliefs yet this state is probably less common than ambivalent attitudes. Attitudes, like beliefs, are judgments, although attitudes take on a strong emotional aspect and designate preference; two qualities that beliefs may have but do not necessitate. Unlike personality, but like beliefs, attitudes are very plastic and expected to change as a function of adult experience. The knowledge garnered by psychologists in the area of attitudes is thought to have useful applications for things like therapeutic attitude change, marketing and personal persuasion (Sherif & Sherif, 1968).

There are several theories about the formation of attitudes, which hold important implications for the formation of beliefs and these include the self-perception theory, the persuasion theory, the elaboration likelihood model and the social judgment theory. The self-perception theory is an account of attitude formation or change developed by psychologist Daryl Bem (1972). It asserts that people develop attitudes by analyzing their own behavior and making conclusions about what attitudes must have caused them. Conventional wisdom dictates that attitudes cause behavior, but there is much evidence now to support the idea that causality can go both ways.

Bem (1972) took this idea further when he propounded that often people determine what their attitude was, after the fact, without accessing or recalling the

cognitive states that led to them. He claimed that in this way, people often explain their own behaviors in the same way that they might explain the behavior of another person. In essence, often unknowingly, they look at themselves from an observer's standpoint. The same process might drive the formation of some beliefs. If so, many beliefs may arise simply when a person commits to a certain act once and then feels pressured to act in a way consistent with this act in the future. Future scenarios may only superficially resemble an initial scenario but the desire to be seen as consistent might cause people to create beliefs that are hasty and poor. Bem's (1972) theory and the self-perception theory of attitudes are very similar to Gazzaniga's (1998) theories regarding the "interpreter" (the language area of the left hemisphere) mentioned in a previous section.

The self-perception theory, which has been supported by a good deal of empirical and clinical research (Robak et al., 2005), suggests that individuals with psychological problems such as anxiety or depression infer their inner feelings from their behaviors. This has become a cornerstone of cognitive-behavioral therapy where the therapist works with the client to gain insight into maladaptive behaviors and the thoughts that are caused by them. The attitudes characteristic of anxiety and depression can play a large role in guiding what is believed. Looking through a list of common personality traits it is clear that a number of dispositions could predispose people to accept certain beliefs over others. It is easy to see that traits such as optimism, neuroticism, openness, introversion, conscientiousness, cynicism, agreeableness or paranoia could each foster very different leanings in belief. Further, as with attitudes and personality styles, beliefs should be more

closely analyzed by therapists because of their potential bearing on therapeutic coping strategies.

Another relevant model of attitude formation and change is the elaboration likelihood model of persuasion (Petty & Cacioppo, 1986). This model makes a distinction between the central route to persuasion which involves the persuaded person thoughtfully deliberating and scrutinizing the persuasive communication, and the peripheral route which involves the persuaded person ignoring the merit and logic of the persuasive communication and instead focusing on secondary factors such as how the message is being delivered or presented (Petty & Cacioppo, 1981). Whether the person is able to take the central route and actually think for themselves is determined by their motivation and ability (Petty & Cacioppo, 1986). Interestingly, attitudes (and presumably beliefs) formed using the central route that were elaborately analyzed are more likely to be stable over time, more likely to be predictive of behavior and more resistant to subsequent, contradictory persuasion (Petty & Wegener, 1999). Again, the literature on attitudes provides a valuable framework for the understanding of beliefs. Certainly one's motivation and ability to analyze the merit and logic of a belief can compete with their inclination to take a "peripheral route" to belief formation.

Social judgment theory, proposed by Muzafer Sherif and Carl Hoveland (1961), is yet another model of attitudes that contributes to the effort of gaining perspective on belief. These theorists argued that the amount of attitude change expected could be shown to be directly proportional to the message receiver's level of interest, the nature of alternative attitudes and the credibility of the source. These researchers asked participants

to categorize statements into piles of most acceptable, unacceptable and neutral in order to observe their decision making behavior. Sherif and Hoveland (1961) concluded that categorization is an observable judgment process that must play a major role in attitude formation. They also concluded that categorization and thus attitude acquisition are products of past experience, prior knowledge, emotion and the current situation (Sherif et al., 1965). This study, by requiring participants to sort statements into categories also uniquely allowed the experimenters to notice another feature of attitudes: even small quantitative differences between two attitudes can be perceived as constituting a qualitative difference. For example, two people that both believe in natural selection may disagree as to the specifics of the role of natural selection in nature. There are many factors that contribute to both attitudes and beliefs and this makes it so that people can agree on a subject, yet disagree as to its parts.

A number of concepts derived from the social psychology of attitudes are particularly relevant to the discussion of beliefs: self-serving bias, false consensus, unrealistic optimism, the fundamental attribution error, saying becomes believing, prior commitment, channel of communication, indoctrination, attitude inoculation, group polarization and deindividuation. That there is little work coordinating or even contrasting these lines of research with the present topic is another indication that beliefs are undertheorized.

Attitude accessibility refers to the degree to which an attitude can be quickly recalled from memory (Fazio et al., 1986). The more accessible an attitude, the more resistant it is to change and the more likely it is to influence behavior (Fazio et al., 1986).

It is thought that some attitudes are not accessible at all. Implicit attitudes, thought to be unacknowledged or outside of awareness, can actually play a large role in behavior despite being inaccessible. Sophisticated methods measuring people's response times to specific stimuli can dissociate implicit attitudes from those that we can report on. The relationship between implicit and explicit attitudes however is thought to be poorly understood.

Persuasion is a form of social influence that guides people toward the adoption of a belief, attitude or action due to the power of appeal. Forms of persuasion that should have a strong effect on beliefs include liking, social proof, and some coercive approaches. "Liking" happens when people are easily persuaded by people or things that they find attractive, amusing or appealing. "Social proof" is similar to the conformity principle discussed earlier and is the process whereby people can be persuaded to believe something or do something that they observe others doing (Cialdini, 1993). Finally the coercive techniques of persuasion recognized by psychologists include: deception, hypnosis, subliminal influence, brainwashing, mind control and torture (Cialdini, 1993). Studies have shown that if there is not enough emotional appeal, attitudes will not change, whereas, if there is too much and the emotional appeal is overdone, the receiver will exhibit reactance and reject the appeal altogether (Fazio et al., 1986). There is no reason to think that appeals to belief would not work this way.

Other methods of attitude persuasion recognized by psychology involve constructs such as reciprocity, commitment and scarcity. "Reciprocity" involves the strategy of indebting someone to you because you know that people tend to return favors

(Fehr & Gachter, 2000). This is thought to contribute to the pervasiveness of free samples seen in many marketing campaigns. “Commitment” involves taking advantage of someone’s prior commitment in order to ensure their continued commitment or patronage. “Scarcity” involves people being successfully persuaded to try something when it is pointed out that this thing will only be available for a short time. These kinds of persuasion have a high likelihood of influencing behavior and attitude but probably do not strongly effect beliefs.

Philosophers recognize different methods of persuasion towards the appeal to reason, namely: logical argument, rhetoric, scientific method and proof (Nelson et al., 1987). They also recognize methods of persuasion that appeal to emotion: advertising, faith, imagination, propaganda, seduction, tradition, pity, hope, jealousy, disgust, indignation, fear and anger. Studies in marketing and advertising have generally shown that whether the appeal is to reason or emotion, repetitious exposure is key (Kilbourne & Pipher, 2000).

Persuasion by authority is an interesting and important appeal, recognized by psychologists and philosophers, which can appeal to reason or emotion. The “argument from authority” or “appeal to authority” is known in psychology to be very persuasive but known in philosophy as a logical fallacy. Such an appeal involves arguing that a statement is true because a person or source that is regarded as authoritative makes the statement. It is regarded as a fallacy because the truth of a statement is not necessarily dependant on personal qualities of the claimant. The argument from authority, though, is embraced by “informal logic” which takes a utilitarian approach to logic. Because no

person can have expert knowledge on every topic, people are forced to rely on the judgments made by people who are experts. Under informal logic, there is no fallacy in appealing to authority except when it is claimed or implied that the authority is infallible (Copi & Cohen, 1998). The more relevant the expertise of an authority, the more compelling their judgments, or their efforts at persuasion, is deemed to be (Bachman, 1995).

Many people are easily persuaded by authorities and can even be impelled by them to perform objectionable acts (Shepard & Greene, 2003). In advertising appeal to authority can be unreasonable because often the person chosen for the endorsement or sponsorship is not qualified as an expert. However, experts can be mistaken, can have views that differ markedly from other experts in their field and sometimes can be willfully deceptive because of pressure from peers, employers or from financial interests (Damer, 1995). All things considered, believing in the knowledge or even opinion of a true authority (assuming their field is legitimate) is often a person's best recourse when it comes to beliefs outside their domain of expertise.

It is probably very common that people acquire beliefs because of persuasive messages. Most information that children receive about the world, from their parents or from school teachers can be described as persuasive. It is probably rare that people acquire beliefs from persuasive advertisements. Advertisements, like other peripheral routes to persuasion, have the ability to change immediate behaviors and even have access to changing attitudes but probably do not change beliefs with much consistency.

<u>What is Next?</u>

This review of the literature shows that beliefs determine what we think, how we behave and largely who we are. Throughout history, thoughtful people have debated the nature of human beliefs and speculated about their sources, stability and substance. Modern psychology, relative to advances on other topics, has paid only very little attention to why individual people believe the things they do and to the factors that influence them to do so. Very little work has recruited participants to contemplate and report on factors that influence their disposition to believe.

Instead, the research has focused on either the semantics of belief; on showing how "arational" or irrational human beliefs can be (Kahneman & Tversky, 1973); on closely related topics such as knowledge and attitudes; or on how to develop decision aids that will circumvent the "irrational" aspects of human beliefs that depart from "rational" models (von Winterfeldt & Edwards, 1986). New work must be proposed to remedy the dearth of empirical, social science research on human beliefs by studying their psychological, sociological and biological foundations. What should this much needed work investigate?

Our research has shown that contributing evidence and the stance of parents may play the most formative roles in the search for justification of belief. The present literature review seems to echo this sentiment, that parents and evidence are determinative, interesting constructs that, unlike so many of the other factors we have considered here, are not opaque to psychological investigation. But what kinds of beliefs are we likely to turn to our parents for? Are these different from those that we search for evidence to support?

Our past research shows that people value what they think their parents believe and what they estimate is good evidence. This data, though unique in scope, does not tell us if children believe what their parents actually believe. To answer this question, we would need to have the parents report their belief strength. We have garnered some ideas for why parents and evidence are so important, but we have not resolved how either makes its unique contribution to certainty strength.

This brief review of past thought about beliefs leads to three important research questions for which there are, surprisingly, few answers:

- What is the role of empirical evidence in determining the strength of an individual's belief?
- What is the role of parents in forming and shaping beliefs?
- What role does a person's sense of self-identity play in belief?

Chapter 16: Psychological Correlates of Belief: Measuring the Relative Influence of Parents, Evidence, Source, and Importance to Self-Identity

Chapter Abstract

Study 1 examined the psychological determinants of personal belief by measuring the contribution of various constructs to certainty strength. The study collected data from over 250 child-parent pairs regarding how physical, social and religious beliefs are formulated. Participants rated their strength of belief in statements within these domains relative to the following determinants: the importance of substantiating evidence, the perceived logic inherent in a belief, the importance to self-identity, the influence of parents, the social community and authority figures. The present research found that substantial correlations exist between the beliefs of children and their parents but that the strongest correlation is the one between a child's belief and the child's estimate of their parent's belief. The study found that strength of certainty can be best predicted by one's estimate of their family member's belief, the quality of empirical evidence that the person can offer to support the belief, and the perceived importance of the belief to their sense of self-identity.

Introduction

The purpose of the 2 studies presented here was to achieve a better understanding of the determinants and functions of belief. Study 1, the topic of this section, sought to examine the determinants of belief formulation by exploring relationships between the beliefs of children and the beliefs of their parents. Study 2, detailed in the next section, examined the role of belief in behaviors and behavioral outcomes by focusing on whether people's self-reported beliefs predicted weight management behaviors and whether these behaviors in turn predicted BMI. These two studies were designed to complement each other. In order to inform behavioral intervention strategies and to better conceptualize belief from ontological, epistemological and critical perspectives, it is necessary to understand both the contributors to belief strength and the role of belief strength in complex behavior and decision making.

Our previous research attempted to determine, which of several different factors had the largest influence on belief strength. Although parents turned out to be the most significant and compelling factor in this research, important questions remained unanswered. Because we did not get data directly from the parents we were not able to discern whether the parents' actual beliefs, or simply their children's estimations of them, influenced the children's beliefs. Study 1 recruited child-parent pairs to determine whether children's beliefs match, not only their estimates of their parents' beliefs, as we have found previously, but also their parents' true beliefs. Study 1 parsed the influence of parents into separate components: children's beliefs, children's estimates of their parents' beliefs, the parents' beliefs and the parents' estimates of their children's beliefs. This

study adds to the knowledge garnered by previous studies by examining the role of parents' actual, self-reported beliefs.

The present study also measured evidential, logical, emotional and environmental determinants of certainty strength so that influence of parents can be considered in the context of competing determinants. The logical determinants examined included rationale, personal account, firsthand and secondhand evidence; the emotional determinants included personal likeability, permanence and relevance and the environmental determinants included opinion of parents and friends, opinions of authorities and other sources of influence. These determinants were gathered from a review of the literature on the components of belief certainty, which is both scarce and divided. Many different contributors to certainty strength have been recognized by previous theorists and researchers over the years and the present study has attempted to examine the most meaningful and compelling of these constructs and to compare their influence to that of parents.

The Treatment of Beliefs in Previous Literature

Much of the existing literature on belief relies on speculation about belief formulation without support from empirical evidence (e.g., Paglieri, 2005; Doyle, 1992; Pennington, 1993). This literature has hypothesized that factors, including our attitudes, our goals, our moods, our sense of self-identity and our stereotypes, have the power to moderate belief strength (Gilovich, 1990; James, 1958). It seems that only a few researchers have attempted to measure certainty strength in specific beliefs as a function of the beliefs of others (Castelfranchi, 1996; Colby, Tesler & Enea, 1969; Becker, 1973).

This research has explored how existing beliefs affect decision making and cognition (e.g., Geraerts et al., 2008; Anderson & Sechler, 1986, Anderson et al., 1980; Costa et al., 1995); however, it has not investigated how individuals appraise different components of belief strength relative to each other. Again, little to no research has attempted to determine which factors are the most powerful in determining belief. Awareness of this dearth of information about the relative value of different contributors to certainty strength influenced us to attempt to identify and then measure several different components of belief formulation in order to use multiple regression techniques to determine how much variation in certainty strength each component can be shown to account for.

A large number of factors have been demonstrated to affect belief strength (Gilovich, 1990). Evaluation of competing beliefs can be affected inadvertently by our liking for them, by our goals, by our moods, and by our stereotypes, all with or without conscious deliberation (James, 1958). According to the Data-oriented Belief Revision (DBR) model (Paglieri, 2005), the number of potential logical, emotional, and developmental determinants that play roles in whether beliefs are accepted or rejected is large and can vary between people and circumstances (Paglieri, 2005). Moreover, it has been shown that evidence, conscious goals and rational thinking influence beliefs. Under different scenarios, transient motivations, subjective biases, and the expectations of others can be more influential (Travis & Aronson, 2007; Tversky & Kahneman, 1974).

Because unconscious responses can manifest themselves in behavior without conscious intent, they can largely affect our "feeling of being certain" without our

awareness (Burton, 2008). For this reason, various determinants that are often not apparent until one takes the time to reflect can influence beliefs (Burton, 2008). Knowledge of how the determinants of beliefs can be transient, unstable, and unavailable to conscious introspection influenced our method for analyzing the determinants of belief. It became clear that we needed to expose participants to multiple beliefs representing different domains and come up with ways to measure several different components of belief formulation in order to see how much variation in belief strength each component can be taken to account for.

The Influence of Parents and Others

As with other forms of learning it seems that learning what to believe starts with adopting or modeling the beliefs of others. Understanding how others introduce us to beliefs and how we conceptualize them in an ontogenetic sense should prove integral to understanding not only how beliefs develop but also how they change with time. James Alcock famously argued that our beliefs have their origins in the influences of authority figures; specifically pinpointing parents as the main influence for most people early in life (Alcock, 1995). Authority figures may also, according to Alcock, influence one's "gut feelings" because, at a young age, one does not necessarily have sufficient empirical evidence to support his or her beliefs (Alcock, 1981). Literature on the development of social theories supports the idea that children primarily adopt beliefs from parents, peers, teachers and other social agents and then create a larger proportion of their own beliefs later in life as experiences accumulate (Alcock et al., 1998; Anderson & Sechler, 1986).

Beliefs, adopted or borrowed during childhood and adolescence, create scaffolding for personal belief building in adulthood.

In young childhood, when many core beliefs are first being formulated, children actively learn about what to believe and how to believe from their parents, teachers and classmates. Many of these early beliefs are formative and resistant to change (Anderson & Sechler, 1986). These findings and others like them may also indicate that beliefs that have emotional concomitants, like many religious and sociological beliefs, have a tendency to become fixed early in life for the same complex reasons that emotional responses and personality become fixed early on. One survey study has shown that people, regardless of age, have a strong tendency to believe in the religion that they were inculcated into during childhood (Argyle, 1997).

In a 1992 book, Parental Belief Systems: The Psychological Consequences for Children, Irving Sigel claimed that belief systems should change with respect to parents' influences over time. He pointed out that if one were to measure similarities in the beliefs of parents and children, it would be important to note how old the children are during the time of the study. Survey and interview-based research has found that young children tend to blindly accept whatever their parents tell them, and may never question these beliefs or even have a full understanding of them (Sigel, 1992). By the time they reach adolescence, they tend to be more rebellious and may want to distance themselves from their parents, in which case they may form their own beliefs and reject the stances taken by their parents. Once individuals reach young adulthood, the similarities in beliefs become less predictable.

David A. Murphey's (1992) research has shown that children are highly likely to adopt the beliefs of people they find charismatic, interesting and inspiring. He points out that the parents that are most successful in effectively transferring their heartfelt belief systems are those that are accepted by their children as role models. Charismatic and loving parents that avoid inciting dissent seem to be the most influential. Similarly, a longitudinal, questionnaire-based study performed by Allan Wigfield (1994) revealed that the more involved a parent is and the more they combine warmth with reasonable levels of authoritative control, the more likely their child is to share their general attitudes and beliefs about the world. Interestingly, beliefs about interpersonal interaction, like parenting style, have been shown to be highly conserved across generations (Simons et al., 1992).

Religious affiliation provides a set of core beliefs that have been shown by psychological experimentation to remain highly stable (Argyle, 2000). Scott Myers of Penn State University published one study examining the heredity of religious beliefs in 1996. The study, which interviewed 471 parents and their adult offspring, attempted to determine the degree to which parental religious beliefs affect their child's chosen religion. The study also attempted to identify some family characteristics that make intergenerational transmission of religious beliefs more likely. The study found that the children's religious beliefs were strongly correlated with the beliefs of their parents. The study also found that religious beliefs are particularly similar amongst close-knit families in which the mother did not work (Myers, 1996). Previous work conducted by Cynthia Clark and colleagues (1988) looking at transmission of religious beliefs to first-born sons

resulted in somewhat similar findings. This work featured 68 mother-father-son triads, where each family member was interviewed about their beliefs. The study incorporated and controlled a large number of potential predictors. Mothers were found to influence son's religious application and practice; whereas, fathers influenced son's church attendance. The authors point out that parents hope to transmit values to their children that are not interfered with by competing transmissions from schooling, media and other adolescents. They implied that this is not always easy. The findings also suggested that parents that served as dedicated, consistent role models were the most influential.

The literature has compared children and parents' beliefs in religious and political domains but has not compared their beliefs to their estimates of each other's beliefs or to other epistemic influences. This motivated us to gather data on the influence of parents in our studies in hopes that we could compare parents, peers, authorities and other social agents in terms of relative influence.

The Influence of Evidence

Once children are able to accumulate evidence from experience to support their beliefs, parents become less important. Theorists have speculated that young people often work concertedly to expose their beliefs, acquired from their parents, to systematic testing. Another popular perspective explains that keeping consistency among our beliefs is a basic human need and an urgent concern during belief formulation (Schick & Vaughn, 2002). People tend to reject facts or statements that are at odds with their current beliefs (Schick et al., 1995). For this reason, many people will embrace evidence that

supports their belief and disregard conflicting evidence in order to maintain cognitive consistency (DeNoma, 2001).

Research also shows that individuals will often maintain a belief in spite of overwhelming amounts of conflicting evidence, and this tendency is termed "unwarranted theory perseverance." After performing several studies and an extensive literature review, Anderson et al. (1980) concluded that people frequently cling to beliefs to a "considerably greater extent than is logically or normatively warranted." Their findings and the findings of others suggest that evidence is often not measured judiciously and that competing beliefs and counter explanations are too often ignored or overlooked (Kida, 2006; Schick & Vaughn, 2002).

These findings influenced us to change the way we gathered data on the importance of evidence. Instead of asking subjects to provide evidence to support their stance on a subject, we asked them to provide evidence to support the truthfulness and falseness of each belief. Subjects were then asked to rate each point of evidence in terms of perceived quality. This allowed us to gather data on how people weigh evidence in favor of and against beliefs.

The Influence of Self-identity

Beliefs that are strongly tied to one's self-identity can be extremely difficult to change. Most people perceive information that is consistent with one's self-identity as more credible than the information that is inconsistent (Levy, 1997). People strive to maintain their sense of self-identity for many reasons. It gives them pride, a feeling of individuality, and a stable view of the world (Markus, 1977). Self-identity maintenance

reinforces one's self-concept and encourages people to reject feedback or information that conflicts with their ideas about themselves (Sutherland, 1992). People will go to great lengths to maintain their sense of identity. They will engage in certain cognitive strategies (most of which they are not fully conscious of) that include selective attention, selective memory, and selective interpretation (Shermer, 2003). It is clear that the desire to keep our beliefs in line with our self-concept determines what kind of feedback we seek from others and from our environment (Gilovich, 1990). Therefore, this study needed to include measures to assess the importance to self-identity.

An article by Castelfranchi (1996) offered a substantial review of the literature on self-concept and broke self-identity into three determinants, relevance, permanence, and likeability. Castelfranchi argued that these three constructs are the main emotional determinants that guide us through the process of accepting or rejecting beliefs and that they ultimately contribute to certainty. These three constructs seemed compelling and represented an apt way to divide self-identity into separate components; therefore, we included them in our research in order to analyze their relative roles in determining certainty strength.

The Influence of Logical Reasoning

An extensive literature on the subject of "belief revision" has elaborated on the differences between two models, the foundations and coherence models (Doyle, 1992). According to foundations theory, beliefs are maintained if they are reasonable, rational, and justified and beliefs are abandoned when an individual obtains evidence to the

contrary. The coherence approach, in contrast, contends that an individual accepts a belief if it logically coheres with other closely held beliefs pertaining to self.

Most people tend to think that the manner in which they choose what to believe is logical; however, the evidence suggests that many people hold beliefs that are not supported by evidence or well-reasoned argument (Kida, 2006). One might think that people derive their beliefs from experience and that the beliefs that they choose to adopt are those that are consistent with sensory perceptions, rational reasoning, and careful deliberation. But how does a reasoned consideration of evidence measure up to the other determinants of belief? Many studies have looked to see what role reasonably convincing evidence plays in certainty strength; yet these studies consider evidence by itself (Schoomer, 1990).

Our Previous Research

Many of the articles cited above rely on speculation about belief formulation without support from empirical research (e.g., Paglieri, 2005; Doyle, 1994; Pennington, 1993). Some of these articles collect data to show that a single determinant of belief affects certainty (e.g., Anderson & Sechler, 1986; Anderson et al., 1980; Geraerts et al., 2008) but fails to consider them relative to each other. In order to build on this knowledgebase about belief strength, we carefully designed our previous research to assess how several important determinants affect people's beliefs when taken together.

In order to identify the determinants most predictive of strong beliefs, we conducted two multivariate studies (Reser, 2009). Together, the two studies attempted to examine the fundamental question "Why do people hold the beliefs they do?" by delving

into the physical, social and religious beliefs of college students. We intended to analyze how the students support, rationalize, think and feel about the beliefs they held. The studies measured the relationships between logical, emotional and environmental determinants of certainty strength.

In the first study, subjects considered 12 individual beliefs that were grouped into three conceptual categories: 1) beliefs about physical existence, 2) beliefs about religion and 3) beliefs about social issues. Subjects were asked to consider the 12 belief statements relative to each of several determinants to assess the contribution of each to the strength of certainty in the statement. The determinants were: 1) the quality of the evidence that the subject can generate to support the truthfulness of the belief statement; 2) the quality of the evidence that the subject can generate to support the falseness; 3) the importance of the belief to the subjects' sense of self-identity if it was true; 4) the importance of the belief to self-identity if it was false.

One question we wanted to address with this study is whether people are logical and rational deliberators who rely on what they take to be empirical evidence to formulate their beliefs. The findings suggested that this is partly true. Subjects wrote what evidence they could offer to support the truthfulness and falseness of each belief. Then they used a 7-point scale to rate their judgment of the strength of each piece of evidence they provided. We used the sum of their evaluation scores in our analyses. The participants' ratings of the quality of evidence (for the truthfulness of the belief) had a strong, positive relationship with their certainty strength (R square values varied from a low of .02 to a high of .11). This relationship was stronger than the positive relationship

between importance to self-identity and certainty strength (These R square values varied between .02 and .29). The best indicator of the strength of certainty though, was the difference between the quality of evidence for the truthfulness and that of the falseness (R square values varied from .08 to .37).

In the second study, we introduced new measures in an attempt to determine how the perceived beliefs of others would compare, in predictive capacity, to quality of evidence and self-identity. This time, subjects gave estimates for the certainty strength of their parents, personal contacts and the average American for each belief and these data were entered into a regression equation. The estimates for certainty strength of the average American varied negatively with participants' estimates, whereas the estimated certainty strength for personal contacts and parents were strong, positive predictors. We were surprised to see that the estimates of parents' beliefs proved to be the strongest predictor of all (R square values varied from a low of .40 to a high of .69) across the six belief investigated. In fact, the second study showed that the influence of personal contacts was generally a better predictor than quality of evidence and that the influence from one's parents was actually far better than either was. See the R-square values in Table A below.

Table A summarizes the major findings from our earlier research. It shows the betas (βs) and R-square (R^2) changes when beliefs were used as dependent variables to predict the independent variables of belief determinants in a stepwise multiple regression analysis. The values shown in the cells of Table A are: (1) the standardized regression coefficients, βs; (2) the R-square change associated with the predictor shown in the

parentheses; (3) the superscript numbers following the parentheses indicate the order of entry in the stepwise regression. The R-square shown in the last column is the total variance accounted for by the predictors that entered the equation. The table highlights the relative importance of the various determinants we measured on the certainty strength of subjects for the six beliefs we assessed in the study. For example, the first row reports that the participants' estimates of the belief strength of their parents predicted 69% of the variance in their belief in the existence of gorillas as a real species of primate. The table also shows that parents' belief was the most important predictor - indicated by the superscript of 1. Similarly, the first row of Table A shows that the perceived belief of scientists was the second strongest predictor of belief in gorillas, accounting for 2% of the variance in the participants' certainty strength. The right most column of Table A shows that the total R-square was 71%. The other beliefs relate to similar questions about the existence of bigfoot, heaven, God, communal laws and the importance of social interaction. The findings reported by this table largely corroborate the speculations of other theoretical writers (Anderson & Sechler, 1986; Alcock, 1981, 1995, 1998; Estes et al., 2003; Fine, 2006) that emphasize the influential effects of personal contacts and especially parents, in decision making and belief formulation.

Table A: Determinants of Belief Strength From Our Previous Study

Belief	Parent	Personal contact	Average Amer.	Scientist	Evid.	Relevant	R^2
Gorilla	.72(.69)[1]			.18(.02)[2]			.71**
Bigfoot	.51(.59)[1]	.18(.02)[3]		.19(.04)[2]			.65**
Heaven	.49(.45)[1]	.15(.02)[5]	-.18(.03)[3]		.25(.07)[2]	.17(.02)[4]	.59**
God	.37(.46)[1]	.19(.03)[4]	-.14(.02)[5]	.14(.02)[6]	.22(.06)[3]	.30(.10)[2]	.67**
Laws	.40(.43)[1]	.29(.07)[2]	-.11(.01)[5]	.24(.04)[3]	.11(.01)[4]		.56**
Social	.58(.40)[1]	.21(.02)[3]	-.20(.02)[2]				.44**

Note. Numbers before the parentheses are the standardized regression coefficients (β). Numbers in parentheses are the R square change associated with the predictor. Superscript numbers indicate the order of entry in the stepwise regression. The R^2 shown in the last column is the total ratio of variance explained by all the predictors. ** $p < .001$

In both of our early studies, the strength of certainty in God held a strong positive relationship with self-identity. In fact, the majority of people reported that their sense of self-identity would be strongly affected both if God were proven to exist and if God were proven to not exist. Furthermore, the findings of the second study suggested that most of this importance to self-identity can be explained by the relevance to self. In both studies, people were certain of their beliefs in the social and religious domains, regardless of whether quality empirical evidence could be presented to support their particular belief. In the domain of physical existence, we found that people were only certain of the beliefs that could actually be bolstered by empirical evidence (such as gorillas and gravity), but, with uncertain beliefs (such as Bigfoot and UFOs), individuals seemed to lack certainty because of the absence of physical or anecdotal evidence.

Both of our previous studies showed that self-reported empirical evidence is a stronger factor in predicting the strength of the belief than the importance to self-identity, which is only moderately contributive. In the first study, even though each of the determinants was important in specific instances, the best indicator of the strength of certainty was the difference between the quality of evidence for the truthfulness and that of the falseness (R square values varied from .08 to .37). The second study generally replicated these findings. Again, in the second study, the quality of evidence proved to be a stronger predictor than the importance to self-identity, with the exception of belief in God. This finding can be interpreted as showing that there may not be much verifiable evidence for the existence of God, and religious beliefs may weigh more heavily in one's sense of self-identity. These empirical findings coincided with the theoretical expectations of other writers that people will first try to base their beliefs on what they think is solid, quality evidence before they are influenced by other factors (Sutherland, 1992; Kida, 2006).

The results from these two studies supported our expectations that strength of certainty in belief is predicted by the quality of empirical evidence participants can offer, the importance of the belief to their self-identity, and what they think their parents and other close associates believe. These factors acted in additive ways to account for the variation in strength of certainty in physical, social and religious areas of thought. Moreover, we found differences in the importance of these predictors across physical, social and religious beliefs that were in line with our predictions.

These studies demonstrated that more research in this area is needed in order to understand how people justify their beliefs and how people's beliefs are influenced by those of their parents. In order to build on the current knowledge and our past findings we designed a new research effort: a questionnaire study that assessed the role of parents' beliefs. This will build on our previous research conceptually to determine the correspondence between children's beliefs and their parents' actual beliefs.

Study 1 focused on five beliefs and attempted to determine the correlation or correspondence between the beliefs of children and their parents. The data and findings from our previous studies were used as a guide to revise our previous questionnaire for use in this study. Despite the fact that the strongest predictor in our previous study was the perception of the parents' beliefs, we could not know if participants were truly influenced by their parents' actual beliefs; instead, they may have simply assumed that their parents share their beliefs. We needed to ascertain the actual beliefs of participants' parents directly from the parents themselves in order to assess whether children: 1) accurately estimated the belief of their parent and 2) shared the belief with their parent. The study includes this key new determinant, the true belief of the child's parent. We planned to use multiple regression to determine how much of the variance in children's belief can be predicted by the parents' actual belief. In addition, we sought to replicate the findings of our two previous studies on the role of self-reported evidence and self-identity in determining certainty strength.

Methods

Participants

Participants were student volunteers recruited from a private research university, the University of Southern California (USC). Individuals from this sample of 532 people participated in our study on "The Foundations of Personal Beliefs" and students received credit toward a course requirement.

A USC institutional review board application, which required us to meet strict guidelines in terms of respect and confidentiality, was submitted and approved. A consent form described the study, its intentions, and the associated risks (see Appendix A). The participants indicated that they understood and agreed to the details of the study. After reading the consent form participants began the questionnaire (see Appendix B) which started with a demographics section.

Demographics

The demographics section of the questionnaire asked participants about their age, gender, level of educational achievement, academic major, hobbies, ethnicity, religious affiliation, and their scientific, social, and religious background. The background questions inquired about the extent to which participants consider themselves scientifically minded, the extent to which they are socially minded, and the extent to which they are religious. Participants were asked to circle a number, 0 through 6, that best describes their response to each question.

Procedure

Participants were given an information sheet with a URL linked to a qualtrics.com questionnaire. There were two online questionnaires, one designed for students and a separate questionnaire designed for the parents. The questionnaire was completed after participants read over a consent form and completed a demographics survey. The survey took participants approximately 25 minutes to complete.

Beliefs Questionnaire

Participants were told to take as much time as they need to finish the questionnaire but were be asked to refrain from discussing the study with their personal contacts until both they and their family member completed the questionnaire. Next, participants were asked to rate five belief statements on a seven-point scale ranging from 0 to 6, indicating the degree to which they think the statements are either true or false. Participants were asked to mark a 0 if they were confident that the statement is false, a three if they were not sure, and a six if they were confident it is true. Next, the participants that were children were asked to make a similar rating to estimate the beliefs of both of their parents, the one taking the questionnaire as well as the non-participating parent. The participating parents were similarly asked to estimate the belief of their child and the other parent for each of the belief statements. We included the estimate of the belief strength of the other parent in order to introduce a third factor that could be compared to the estimates of the parents and children taking the questionnaire. We expected that the estimated ratings of the other parent might serve as a unique predictor that captures unique variance in belief strength. Also, we wanted to determine how much the parent taking the questionnaire reports being affected by the other biological parent

of their child (presumably this other parent was most commonly their spouse or ex-spouse). The five beliefs considered are listed in Table 1 below.

Table 1: List of Belief Statements

1. Bigfoot or Sasquatch is a large animal found on Earth.
2. A Supreme Being or "God" exists in some form.
3. Women have extremely limited access to the highest leadership positions in society.
4. Every American should purchase a home as early in adulthood as possible.
5. Every adult should exercise, from youth to old age, at least 5 times every week for 30 minutes or more, performing a combination of aerobic and strength training activities.

The next section of the questionnaire asked participants to reconsider the beliefs and provide the reasons to support the truthfulness for each. After giving up to five reasons, or points of evidence to support the veracity of the belief statement, they were asked to rate each of their reasons in terms of its explanatory strength. The reasons were rated on a scale from 0 to 6, with zero indicating an insignificant reason, three indicating a significant reason, and six indicating a very significant reason. After rating each belief statement, participants were asked to list and then rate reasons to support the falseness for each. As a result, we obtained 10 sets of evidence, 5 supporting the truthfulness and 5 supporting the falseness.

In the third section, as in our previous study, participants were asked to rate the influence of different sources of information on their beliefs. These sources included personal accounts, secondary source evidence, social consensus, logic and reason, and authorities, such as scientists, political scholars, and religious leaders. Respondents used a seven-point scale, ranging from 0 indicating "a very insignificant source" to 6 indicating a "very significant source", to rate the importance of each of these sources of information in supporting their belief.

The final section of the questionnaire assessed the importance of the belief to the individual or their self-identity. Importance was divided into three subcategories, likeability, permanence, and relevance, according to Paglieri (2005). These items were measured on a 7-point scale, with 0 indicating very unlikeable, impermanent, or irrelevant and 6 indicating very likeable, permanent, or relevant. The three facets of personal importance were defined on the questionnaire as follows. Likeability: How much you personally like your belief. Permanence: How stable, and unlikely to change, is your belief. Relevance: How important or relevant the belief is to your sense of self-identity; the degree to which your world would be turned upside down if you were to find out that your belief was wrong.

Results and Discussion

We had a total of 532 participants and 256 complete child-parent pairs. The average child was 22 years old (with a standard deviation of 5.0 and median age of 21) and the average parent was 52 years old (with standard deviation of 7.7 and median age of 51). The data contained 85 male children, 171 female children, 96 fathers, and 160

mothers. The child's group was 33% male whereas the parents' group was 38% male. The sample was roughly 43% White, 33% Asian, 10% Hispanic, 5% Black, 3% Indian, 1% Pacific Islander and 6% Other.

We were interested to see if the averages in belief strength between the two groups, children and parents, differed, possibly due to cultural or cohort effects. The group averages are summarized in Table 2.

Table 2: Averages of the Certainty Strength of Parents and Children

	Child's Rating	Parents' Rating	Child's Estimate of Parent	Parents' Estimate of Child	Child's Estimate of other Parent	Parents' Estimate of other Parent
Bigfoot	2.28	2.48	2.09	2.79	2.23	2.56
God	5.04	5.42	5.41	5.04	5.22	5.25
Women	4.19	4.13	4.28	4.04	4.29	4.19
Home Ownership	4.30	4.55	4.35	4.41	4.38	4.89
Exercise	5.88	5.73	5.60	5.70	5.40	5.37

Certainty strength was measured on a Likert scale ranging from 0 to 6

The parents had slightly higher average belief in God, home ownership and Bigfoot. For instance, parents' belief strength in God was significantly larger ($M = 5.42$, $SD = 1.11$) when compared to that of children ($M = 5.04$, $SD = .80$), $t(521) = 4.00$, $p < .05$. When estimating each other's beliefs, both parents ($M = 5.41$, $SD = 1.31$) and children ($M = 5.04$, $SD = 1.56$), $t(524) = 3.21$, $p<.05$, seemed to recognize this discrepancy. Further, parents and children had very similar average estimates concerning the other parents' belief in God (5.22 and 5.25, not significantly different), which would be expected if families have knowledge about each other's religious attitudes.

Interestingly, this same general pattern of relationships were revealed when we assessed these beliefs using a completely different format. Another measure introduced later in the questionnaire, asked participants to indicate their certainty by either judging the belief true or false. This gave us a dichotomous measure to assess certainty strength which closely matched the continuous data reported in Table 2. The results of this discontinuous measure are reported in Table 3.

Table 3: Percentage of Participants Judging the Belief Statements as Either True of False

	Children True	Children False	Parents True	Parents False
Bigfoot	17%	83%	21%	79%
God	73%	27%	82%	18%
Women	63%	37%	54%	46%
Home	51%	49%	65%	35%
Exercise	90%	10%	78%	22%

The preceding belief averages are interesting relative to the information collected about extent of scientific, religious and social thinking found in Table 4. These data indicate that children are more likely to rate themselves as scientifically minded (M= 5.4, SD=1.21) relative to the parents' (M = 4.8, SD = .79), $t(527) = 4.31$, $p<.05$. Children also rated themselves as more socially minded as indicated by a mean score of 5.24 (SD = 2.3) relative to the parents' score of 5.10 (SD = 1.2), $t(526) = 3.21$, $p < .05$). Finally, importance of religious faith was rated more highly by parents (M = 4.87, SD = 2.44) compared to children (M = 3.93, SD = .86), $t(526) = 4.56$, $p < .05$. These findings appear

to be consistent with the parents' higher belief in God, lower belief in the benefits of exercise and their relative willingness to believe in Bigfoot.

Table 4: Averages of Self-Rated Orientations for Parents and Children

	Children	Parents
Scientifically Minded	5.41 (1.08)	4.8 (1.67)
Socially Minded	5.24 (1.25)	5.10 (1.53)
Religious Minded	3.93 (2.07)	4.87 (1.05)

Self-rated scientific, religious and social orientations were measured with a Likert scale ranging from 0 to 6. Numbers in parentheses are standard deviations.

Table 5 offers the mean and standard deviation for the components of self-identity for each of the five beliefs. The table suggests that parents found their belief in Bigfoot, God, women, and home ownership more permanent, likable, and relevant compared to children. The differences between the means for parents and children were significant at α=.05 for all except the likeability of exercise. For example, the mean permanence rating by children for the importance of owning a home ($M = 4.56$, $SD = 1.49$) was significantly lower than the same mean rating for parents ($M = 5.09$, $S = 1.84$) $t(522) = 4.56$, $p < .05$.

Table 5: Mean Ratings of Permanence, Likeability, and Relevance by Belief

	Child's Rating of Likeability	Child's Rating of Permanence	Child's Rating of Relevance	Parents' Rating of Likeability	Parents' Rating of Permanence	Parents' Rating of Relevance
Bigfoot	4.37 (2.11)	4.43 (2.10)	2.29 (2.74)	4.63 (1.73)	4.64 (2.33)	2.95 (1.74)
God	5.50 (1.66)	5.27 (1.75)	5.31 (1.76)	5.86 (1.05)	5.79 (1.61)	5.63 (1.99)
Women	4.36 (1.92)	4.54 (1.47)	4.78 (1.78)	4.84 (1.34)	4.94 (1.48)	5.03 (1.28)
Home	4.71 (1.62)	4.56 (1.49)	4.39 (1.71)	5.23 (1.95)	5.09 (1.84)	4.58 (1.11)
Exercise	5.96 (1.48)	5.83 (1.47)	5.84 (1.53)	5.97 (1.74)	5.96 (1.26)	5.70 (1.07)

Self-identity factors were measured with a Likert scale ranging from 0 to 6. Numbers in parentheses are standard deviations.

Tables 6 and 7 present the averages for the ratings of source of influence. The numbers show that there was a high amount of variability in ratings. These tables show that first hand evidence is generally stronger than second hand evidence, and social consensus except in the case of Bigfoot. This seems reasonable considering that participants from our sample probably did not have first-hand experience with Bigfoot. Rational argument rivals 1st hand evidence in importance in providing credibility for a belief. Also, the opinions of scientists were rated the most important of the three expert opinion factors (scientists, political leaders, religious leaders) for belief in Bigfoot ($M = 3.37$, $SD = 2.16$ for children, and $M = 3.25$, $SD = 2.11$ for parents), and for the benefits of exercise ($M = 5.75$, $SD = 1.71$ for children, and $M = 5.77$, $SD = 1.37$ for parents), whereas opinion of political leaders was most important for the belief in the rights of women ($M = 4.39$, $SD = 1.78$ for children, and $M = 4.14$, $SD = 1.95$ for parents) and opinion of religious leaders was the most important for belief in God ($M = 4.15$, $SD = 2.26$ for children, and $M = 4.88$, $SD = 2.30$ for parents).

Table 6: Mean Ratings of Significance of Source by Belief for Children

	1st Hand	2nd Hand	Social Consensus	Rational Argument	Opinion of Scientists	Opinion of Political Leaders	Opinion of Religious Leaders
Bigfoot	2.35 (2.23)	2.83 (1.93)	2.61 (1.64)	2.97 (2.06)	3.37 (2.16)	2.24 (1.64)	1.88 (1.36)
God	4.03 (2.45)	3.21 (2.20)	4.26 (2.06)	4.03 (1.99)	3.41 (2.09)	2.98 (1.87)	4.15 (2.26)
Women	5.01 (1.81)	4.92 (1.71)	4.81 (1.55)	4.60 (1.69)	3.88 (1.83)	4.39 (1.78)	2.96 (1.81)
Home	4.13 (2.03)	3.84 (1.9)	4.01 (1.7)	4.57 (1.85)	2.97 (1.82)	3.09 (1.84)	2.37 (1.72)
Exercise	5.84 (1.67)	5.79 (1.48)	5.43 (1.63)	5.81 (1.56)	5.75 (1.71)	3.48 (2.20)	2.97 (2.12)

Sources of influence were measured with a Likert scale ranging from 0 to 6. Numbers in parentheses are standard deviations.

Table 7: Mean Ratings of Significance of Source by Belief for Parents

	1st Hand	2nd Hand	Social Consensus	Rational Argument	Opinion of Scientists	Opinion of Political Leaders	Opinion of Religious Leaders
Bigfoot	2.43 (2.27)	3.00 (2.09)	2.61 (1.81)	2.93 (2.06)	3.25 (2.11)	1.98 (1.49)	2.07 (1.67)
God	4.30 (2.45)	3.74 (2.35)	4.58 (2.09)	4.31 (2.09)	3.52 (2.15)	3.00 (2.11)	4.88 (2.30)
Women	4.95 (1.98)	4.75 (1.79)	4.79 (1.72)	4.76 (1.71)	4.01 (2.02)	4.14 (1.95)	3.32 (1.97)
Home	4.85 (2.00)	4.17 (2.01)	4.59 (1.69)	4.82 (1.73)	3.40 (1.91)	3.18 (1.88)	2.58 (1.71)
Exercise	5.75 (1.67)	5.73 (1.59)	5.47 (1.58)	5.64 (1.54)	5.77 (1.37)	3.19 (2.09)	3.06 (2.01)

Sources of influence were measured with a Likert scale ranging from 0 to 6. Numbers in parentheses are standard deviations.

Table 8 is a summary table that offers the Pearson's correlation coefficients associated with children's and parents' beliefs and their estimates of each other's beliefs. Squaring these correlations gives us R-square values, which indicate the percentage of variance accounted for. Column three of Table 8 offers the correlations between the children's ratings and the children's estimates of the parents' ratings. This is the only column in the table that directly mirrors the data collected in our previous study as each

of the other columns feature data that was not collected previously. As in our previous study, this relationship appears strong. The R-square values associated with this relationship vary between a low of .43 for belief in God to .56 for the belief in women's access to leadership positions.

The correlations in column three constitute the highest in the table and in fact were consistently the highest out of all correlations, for each belief. Column three partially replicates the findings related to parents in Table A above. For instance, in Study A children's estimate of the parents' belief accounted for 59% of the variance in children's certainty in Bigfoot, whereas in Study 1, it accounted for 52%. Similarly, in Study A children's estimates accounted for 46% of the variance in certainty in God, and in Study 1 it accounted for 43%.

The R-square values in column three can be compared to those in column six, which provides the correlation between the parents' ratings and the children's estimates of the parents' ratings. These R-square values are actually much lower and range between .08 and .38 (average = .20). We designed this study to assess these correlations so that we could determine if parents actually believe what their children think they believe. This is the first suggestion that children's beliefs are less closely related to their parents' actual beliefs than they are to the children's estimates of them.

Another interesting comparison is between columns two and three. Column two gave the correlations between children's ratings and parents' ratings. For each belief, the R-square values in column two were smaller than those in column six. The R-squares found in column two ranged from a low of .06 for the belief in home ownership to a high

of .17 for the belief in God (average = .10). We initially sought to determine if children's and parents' beliefs correlate better with their estimates of the others' beliefs or with the others' actual beliefs. As column two demonstrates, the correlations between the actual beliefs of parents and children are consistently the lowest in the table.

The fourth column holds the correlations between the parents' ratings and the parents' estimates of the children's ratings. The R-square values in this column were relatively high and resemble those in column 3. The values in this column suggest that the parents think that the child believes what they do. In other words, columns three and four, when compared to column two, indicate that both children and parents overestimate the degree of shared belief.

Row two in column five gives the correlation (.644) and R-square (.415) for the relationship between children's rating and the parents' estimate of the children's rating for belief in God. This relationship, compared to the others in the column, is strong. It suggests that parents in our sample, relative to the other beliefs, had reliable knowledge of their children's beliefs in God. This correlation was significantly higher than the correlation (.417) between the parents' rating for God and the children's rating (Fisher's z = 3.57, p = .0002).

Table 8: Summary Table for Correlations Between the Beliefs of Parents and Children

	Child's Rating vs. Parents Rating	Child's Rating vs. Child's Estimate of Parent	Parent's Rating vs. Parents Estimate of Child	Child's Rating vs. Parent's Estimate of Child	Parent's Rating vs. Child's Estimate of Parent	Child's Rating vs. Child's Estimate of Other Parent	Parent's Rating vs. Parent's Rating of Other Parent
Bigfoot	.278 (.077)	.718 (.516)	.717 (.514)	.382 (.146)	.398 (.158)	.344 (.118)	.677 (.458)
God	.417 (.174)	.658 (.433)	.584 (.341)	.644 (.415)	.619 (.383)	.454 (.206)	.481 (.231)
Women	.286 (.082)	.751 (.564)	.739 (.546)	.290 (.084)	.292 (.085)	.705 (.497)	.657 (.431)
Home	.262 (.069)	.720 (.518)	.670 (.449)	.296 (.088)	.366 (.134)	.781 (.670)	.679 (.461)
Exercise	.300 (.090)	.675 (.456)	.612 (.375)	.379 (.144)	.494 (.244)	.665 (.442)	.582 (.339)

Numbers before parentheses are Pearson's correlation coefficients. All correlations were significant at the .01 level, $r(530)$, $p<.01$. Numbers in parentheses are R-square values.

The last two columns of Table 8, columns 7 and 8, show that both the children and the parents expected that the other parent that was not part of the questionnaire, generally shared their beliefs. For example the R-squares for the correlation between the children's ratings and the children's ratings of the other parent ranged between .18 and .67. The data in the following tables also give the correlations between the children's estimate of one parent and their estimate of the other parent. These correlations were among the highest values in these tables indicating that, on average, children estimate that their parents have relatively similar beliefs (R-squares ranged between .09 and .45).

Tables 9-13 below provide the original correlation matrices from which Table 8 was constructed and contain all possible correlations between certainty and estimates of certainty for children, the parent that took the questionnaire and the child's other parent. We designed this study to assess these correlations, and the related multiple regression equations, so that we could determine if parents actually believe what their children think they believe. The tables below offer glimpses at the answers.

Table 9: Correlations Between the Beliefs of Parents and Children for Belief in Bigfoot

	Child's Rating	Parents' Rating	Child's Estimate of Parent	Parents' Estimate of Child	Child's Estimate of other Parent	Parents' Estimate of other Parent
Child's Rating	x	.278	.718	.382	.344	.377
Parents' Rating		x	.398	.717	.344	.677
Child's Estimate of Parent			x	.378	.612	.402
Parents' Estimate of Child				x	.435	.706
Child's Estimate of other Parent					x	.413

All correlations were significant at the .01 level, r(530), p<.01.

Table 10: Correlations Between the Beliefs of Parents and Children for Belief in God

	Child's Rating	Parents' Rating	Child's Estimate of Parent	Parents' Estimate of Child	Child's Estimate of other Parent	Parents' Estimate of other Parent
Child's Rating	x	.417	.658	.644	.454	.344
Parents' Rating		x	.619	.584	.438	.481
Child's Estimate of Parent			x	.472	.481	.587
Parents' Estimate of Child				x	.356	.565
Child's Estimate of other Parent					x	.587

All correlations were significant at the .01 level, r(530), p<.01.

Table 11: Correlations Between the Beliefs of Parents and Children for Belief in Women

	Child's Rating	Parents' Rating	Child's Estimate of Parent	Parents' Estimate of Child	Child's Estimate of other Parent	Parents' Estimate of other Parent
Child's Rating	x	.286	.751	.290	.705	.238
Parents' Rating		x	.292	.739	.288	.657
Child's Estimate of Parent			x	.209	.632	.168
Parents' Estimate of Child				x	.300	.688
Child's Estimate of other Parent					x	.337

All correlations were significant at the .01 level, r(530), p<.01.

Table 12: Correlations Between the Beliefs of Parents and Children for Belief in Home

	Child's Rating	Parents' Rating	Child's Estimate of Parent	Parents' Estimate of Child	Child's Estimate of other Parent	Parents' Estimate of other Parent
Child's Rating	x	.262	.720	.296	.781	.258
Parents' Rating		x	.366	.670	.302	.679
Child's Estimate of Parent			x	.271	.665	.288
Parents' Estimate of Child				x	.343	.719
Child's Estimate of other Parent					x	.372

All correlations were significant at the .01 level, r(530), p<.01.

Table 13: Correlations Between the Beliefs of Parents and Children for Belief in Exercise

	Child's Rating	Parents' Rating	Child's Estimate of Parent	Parents' Estimate of Child	Child's Estimate of other Parent	Parents' Estimate of other Parent
Child's Rating	x	.300	.675	.379	.665	.345
Parents' Rating		x	.494	.612	.378	.582
Child's Estimate of Parent			x	.373	.667	.321
Parents' Estimate of Child				x	.359	.661
Child's Estimate of other Parent					x	.512

All correlations were significant at the .01 level, r(530), p<.01.

Again, for every belief the correlation between the children's rating and the parents' rating is lower than the correlation between the children's rating and the children's estimate of the parents rating (Fisher comparison, $p < .05$). With the belief about exercise for example, the correlation between the children's rating and parents' rating is .300 and the correlation between the child's rating and the child's estimate of the parents rating is .675. A Fisher r-to-z transformation reveals a z value of 5.81($p = .0001$) indicating that the former is significantly smaller. Fisher r-to-z transformations reveal the same for the other four beliefs as well.

Without exception, the highest correlations found were those between the child's rating and the child's estimate of parents' rating. Close behind these correlations were the correlations between the parents' ratings and the parents' estimates of the children's

ratings. That these two sets of correlations were close in magnitude suggests that parents think that their children believe what they do, nearly as strongly as children think that their parents' believe what they do. In order to reveal firm answers to the questions about child and parent beliefs that this study was designed to analyze, we turn to multiple regression. Regression is helpful specifically because it will allow us to bring the other variables that we measured into the conversation and determine the relative role of each in predicting belief strength.

Multiple regression analyses were used to analyze the influence of the different determinants on belief strength. Five stepwise multiple regression equations were generated - one for each of the five belief statements - in order to uncover the influence of evidence, others' beliefs, and self-identity on certainty strength. Each of the regression analyses used the strength of respondents' belief as the dependent variable. Six independent variables were entered into each stepwise analysis in Table 14 below. These variables were: (1) the estimate of the parents' certainty strength; (2) the estimate of the other parents' (not taking the questionnaire) certainty strength; (3) the difference between the strength of the evidence offered for the truthfulness and falseness of the belief; (4) the likeability; (5) permanence; and (6) relevance of the belief. These regression equations were repeated for the parents (Table 15) and then again for the children with the parents' true certainty strength included in the equation (Table 17). We expected to replicate our findings from the previous studies by showing that estimates of parents' belief have the highest betas followed by the significance of evidence, self-identity, and finally source of

evidence. In fact, source of evidence did not enter as a significant predictor in any of the regression analyses and thus has not been included in any of the tables.

Table 14 shows the betas (βs) and R-square (R^2) changes in a stepwise multiple regression analysis. The values shown in the cells of Table 14 are: (1) the standardized regression coefficient associated with each predictor; (2) the R-square change, shown in the parentheses; (3) the order of entry in the stepwise regression, indicated by the superscript numbers following the parentheses. The R-square shown in the last column is the total variance accounted for by the predictors that entered the equation. Only statistically significant findings at $p < .05$ are included in the table; blank table cells were not statistically significant contributors to the prediction.

Table 14 highlights the relative influence of the determinants we measured on the certainty strength of subjects for the five beliefs we assessed in the study. For example, the second row reports that the participants' ratings of the importance of evidence ($\beta = .47$ and $R^2 = .45$) was the most important predictor for belief in God (indicated by the superscript of 1) and predicted 45% of the variance in their belief in the existence of God. Similarly, the second row also shows that the relevance to self-identity was the second strongest predictor of belief in God ($\beta = .38$ and $R^2 = .16$), accounting for 16% of the variance in the participants' certainty strength. Further, the children's estimate of parent A's belief strength ($\beta = .26$ and $R^2 = .05$) came in third, accounting for 5% of the variance. The right most column of Table 14 shows that 67% of the variance in belief in God is explained by the study's factors.

Table 14: Stepwise Regression Analyses for Variables Predicting Child's Belief Strength

Statement	Estimated Parent A's Belief Strength[1]	Estimated Parent B Belief Strength[2]	Difference in Evidence	Likability	Permanence	Relevance	R^2
Bigfoot	.39(.47)[1]	.26(.03)[3]	.20(.05)[2]		-.11(.01)[4]		.56**
God	.26(.05)[3]		.47(.45)[1]			.38(.16)[2]	.67**
Women	.47(.51)[1]	.30(.05)[3]	.22(.06)[2]				.62**
Home	.55(.47)[1]		.23(.04)[3]	.24(.08)[2]			.59**
Exercise	.51(.38)[1]		.16(.02)[3]			.30(.11)[2]	.52**

Note. The values are the standardized regression coefficients or βs, in parentheses is the R-square change associated with the predictor. Superscript numbers indicate the order of entry in the stepwise regression. The R-square shown in the last column is the total ratio of variance explained by all the predictors. [1] The parent who took the survey.[2] The other parent who did not take the survey.** $p < .001$

We were interested to see if the multiple regression analyses would mirror our previous results and what role the actual belief of parents would play. Table 14 largely replicates our previous results. The children's estimate of the parents' belief strength, shown in the second column of Table 14, entered as the first predictor of belief for all beliefs (except for the belief in God where difference in evidence entered first). The children's estimate of the parents' belief strength, for the other four beliefs, captured variance ranging between a low of 38% for belief in exercise and 51% for belief in women's rights.

Difference in evidence, found in column four of Table 14, was the only other variable that captured variance for each of the five beliefs, ranging from 2% for the belief in exercise to 45% for belief in God where it entered first. It either entered second or third

for the other beliefs indicating that it was typically the second best predictor of belief strength. Each of the other variables entered into at least one of the regression equations where they captured significant but not large amounts of variance. It is interesting to note that likeability entered second for the regression for belief in home ownership (β= .24 and R^2 = .08) and that relevance entered second for the beliefs in God (β= .38 and R^2 = .16) and for the importance of exercise (β= .30 and R^2 = .11). Perhaps this showed that God and exercise were judged as personally relevant, and were given credence due to this, by our participants. However, very few of the self-identity items entered as significant predictors and only relevance accounted for any substantial amount of variance.

Table 15: Stepwise Regression Analyses for Variables Predicting Parents' Belief Strength

Statement	Estimated Child's Belief Strength	Estimated Parent B Belief Strength[1]	Difference in Evidence	Likability	Relevance	R^2
Bigfoot	.34(.10)[2]	.47(.48)[1]	.20(.04)[3]			.62**
God	.25(.04)[3]		.35(.16)[2]	.34(.31)[1]		.51**
Women	.38(.12)[2]	.45(.51)[1]	.14(.02)[3]			.64**
Home	.23(.02)[3]	.59(.68)[1]	.23(.06)[2]			.77**
Exercise	.32(.09)[2]	.33(.49)[1]	.23(.05)[3]		.20(.03)[4]	.66**

Note. The values are the standardized regression coefficients or βs, in parentheses is the R-square change associated with the predictor. Superscript numbers indicate the order of entry in the stepwise regression. The R-square shown in the last column is the total ratio of variance explained by all the predictors. Nothing entered for the variable permanence. [1] The other parent who did not take the survey.** $p < .001$

Table 15 recreates Table 14 but instead of predicting children's belief strength it predicts that of the parents. Table 15 largely echos Table 14 in the sense that parent's estimates of children's beliefs (column two) and difference in evidence (column four) were major factors. Both entered either second or third in the regression equations. Table 14 and 15 were very similar with one exception. Parents' beliefs were related to their estimates of their children's beliefs but were more strongly related to their estimates of the other parents' beliefs (potentially their spouse or ex-spouse). In fact, parents' estimates of the other parents' belief entered first for each belief except for the belief in God. Estimates of the other parents' beliefs captured between 68% (home) and 48% (Bigfoot) of the variance in parents' ratings. This suggests that even though children are likely to believe what they think their parents believe, that parents are not equally as influenced by their estimates of their children's beliefs as they are by the beliefs of their children's other parent. For instance, in the multiple regression predicting parents' belief in the importance of owning one's own home, parents' estimate of the parent not taking the questionnaire came in first ($\beta = .59$ and $R^2 = .68$), the difference in evidence came in second ($\beta = .23$ and $R^2 = .06$), and the estimate of the child's belief strength came in third ($\beta = .23$ and $R^2 = .02$). Together these predictors accounted for 77% of the variance in belief strength.

The other parent's estimate did not enter into the regression equation for the belief in God and it is unclear why this is so. Likeability entered first for belief in God ($\beta = .34$ and $R^2 = .31$), capturing 31% of the variance. Difference in evidence entered second ($\beta = .35$ and $R^2 = .16$) capturing 16% followed by the estimate of the children's belief which

entered last (β= .25 and R^2 = .04) and captured 4%. Overall, these three variables accounted for 51% of the variability in parents' belief strength for God.

Table 16: Stepwise Regression Analyses for Variables Predicting Child's Belief Strength

Statement	Parent A's Actual Belief Strength[1]	Difference in Evidence	Likability	Permanence	Relevance	R^2
Bigfoot	.24(.06)3	.36(.19)[1]		-.26(.08)2		.32**
God	.13(.02)3	.50(.43)[1]			.42(.18)2	.63**
Women		.41(.17)[1]				.17**
Home		.47(.29)[1]	.24(.06)2			.34**
Exercise			.37(.32)1		.29(.04)2	.37**

Note. The values are the standardized regression coefficients or βs, in parentheses is the R-square change associated with the predictor. Superscript numbers indicate the order of entry in the stepwise regression. The R-square shown in the last column is the total ratio of variance explained by all the predictors. [1] The parent who took the survey. ** $p < .001$

Table 16 shows the regression equations by belief for children's belief strength again, but this time we removed the child's estimates from the regression equation to see if parents' actual belief strength can capture variance when entered alone. It captured a small amount of variance, entering third, for belief in both Bigfoot (β= .24 and R^2 = .06) and God (β= .13 and R^2 = .02) but not entering for the other beliefs. When the estimate of the parents' belief is dropped, the difference score for evidence entered first for each belief, with the exception of exercise, where difference in evidence did not enter at all. For the final regression equation we added all of the predictors simultaneously in order to see which would enter significantly.

Table 17: Stepwise Regression Analyses for Variables Predicting Child's Belief Strength

	Estimated Parent A's Belief Strength[1]	Estimated Parent B's Belief Strength[2]	Parent A's Actual Belief Strength	Diff. in Evidence	Likabil.	Perman.	Relevance	R^2
Bigfoot	.43(.47)[1]	.21(.02)[3]		.20(.06)[2]		-.12(.01)[4]		.55**
God	.27(.06)[3]			.45(.44)[1]			.41(.19)[2]	.69**
Women	.46(.47)[1]	.25(.03)[3]		.26(.08)[2]				.58**
Home	.53(.44)[1]			.26(.08)[2]	.18(.03)[3]			.55**
Exerc.	.51(.47)[1]			.13(.02)[4]	.19(.02)[3]		.22(.13)[2]	.61**

Note. The values are the standardized regression coefficients or βs, in parentheses is the R-square change associated with the predictor. Superscript numbers indicate the order of entry in the stepwise regression. The R-square shown in the last column is the total ratio of variance explained by all the predictors. [1] The parent who took the survey.[2] The other parent who did not take the survey.** $p < .001$

Table 17, the final regression analysis, includes all of the same independent variables as Table 14, with the addition of the parents' actual belief strength. The correlations in Tables 8-13 showed that parents' actual belief is not as strongly related to children's belief as the children's estimate of the parents' belief. Table 17 indicates that the parents' actual beliefs did not have any predictive value or significance as a variable even though its addition as a 7th independent variable slightly altered the significance of some of the other independent variables when added to the equation. Besides this, Table 17 is very similar to table 14. In Table 17, the values for total R-square range from .55 for belief in Bigfoot to .69 for belief in God. As Table 16 shows, these high R-square values shrink when estimates of belief strength are removed as predictors. Overall, children's

estimates of their parents' beliefs turned out to be the most influential predictors of children's beliefs, even greater than the difference score in evidence and the parent's actual beliefs.

Conclusions

The results from the study supported our predictions that strength of certainty in a belief can be predicted by the quality of empirical evidence participants can offer, the importance of the belief to their self-identity, and what they think their parents believe. These relationships were found in the simple correlation matrices and multiple regression analyses, both of which largely corroborated each other. Moreover, in line with our predictions, we found consistent differences in the importance of these determinants across beliefs from different domains. The strongest relationship in previous studies was between the estimate of parents' belief and the child's personal belief strength. However, the present investigation was designed to assess if people are actually influenced by the parents true beliefs, or if they attribute their own beliefs to their parents. We expected that individual child-parent pairs would tend to show a significant correlation in their personal ratings, they do, but it is not as significant as the majority of the other relationships that we measured.

With Study 1, we were interested in whether we could replicate the results of our previous study showing that children believe what they think their parents believe. This relationship actually represented the highest correlation, out of all correlations, for each belief and was further borne out by the regression analyses. We found that children do inflate the similarity between their beliefs and their parents' beliefs. Thus, participants

seem to reliably agree with what they estimate their parents believe, more so than they agree with or understand what their parents actually believe. Tables 16 and 17 made it clear that children and parents' beliefs corresponded more closely with their estimates of the others' belief than they corresponded with the others true belief. In fact, Table 17 shows that the parents' actual beliefs did not even enter significantly into the regression equations as predictors of their children's beliefs once estimates were entered along with them. Further, Table 16 showed that parents' actual beliefs accounted for only very little variance, in only two of the beliefs, when they were entered without the estimates of parents' beliefs.

It is unclear why the children in our study overestimated the similarity between their beliefs and the beliefs of their parent. Could it be a misperception, or perhaps a misattribution? It might be due to the fact that children treat their parents as closely connected individuals; therefore, they either explicitly or implicitly assume that their parents should share their opinions. Perhaps children know that they inherited many of their earliest beliefs from their parents and this knowledge causes them to implicitly assume that they and their parents share more in common than they actually do. If this hypothesis is correct, then the parents' belief as estimated by children are just a distorted proxy of the children's own belief and thus a deceptive predictor of the children's actual beliefs. How much do close associates discuss the details of their own belief systems and how often do they merely assume that others around them share their beliefs? These questions could be topics of future research in this area.

Another question we wanted to address with this study is whether people are logical and rational deliberators who rely on what they take to be empirical evidence to formulate their beliefs. The findings suggest that this is partly true. As with our past studies, the participants' ratings of the quality of evidence had a strong, positive relationship with their belief strength. Again, the effect of the weight of evidence on belief strength was significantly stronger than the effect of self-identity and source of influence. We know that perceived high-quality of evidence turned out to be the strongest predictor of belief strength in our data, after the estimate of parents' beliefs. In fact, evidence emerges as the strongest predictor of beliefs once the illusory contribution of the children's perceptions regarding their parents' beliefs is left out of the equation. These findings corroborate the speculations of other researchers that emphasize the influential effects of parents (Anderson & Sechler, 1986; Alcock, 1995; Fine, 2006; Levy, 1997; Lewis et al., 2001; Markus, 1977) and evidence (Sutherland, 1992; Kida, 2006) in decision making and belief formulation. However, past belief researchers extolling the importance of parents may not have anticipated or accounted for the fact that parent's beliefs may make their impact on children's beliefs indirectly.

The findings show that the effects of evidence and parents are nuanced. What the child thinks the parent believes affects them the most, followed by evidence, followed by self-identity concerns, followed by what the parent actually believes, followed finally by other sources of influence. Overall, the results of the study showed that the variables measured acted in additive ways to account for the variation in strength of certainty in belief.

Future Directions

The reasons that people use to justify their beliefs should be analyzed more carefully in order to better understand how people support their beliefs, if their beliefs are justifiable and how they are related to the beliefs of their close contacts. A wider group of beliefs should be investigated to determine the range of factors that predict belief strength. Furthermore, experimental studies are needed to examine whether or not the variables identified are indeed causal factors in influencing beliefs.

Experimental Analysis of The Influence of Evidence and Others

We have designed and received IRB approval for an experimental investigation designed to examine the effect of evidence and social interaction on belief strength. This study seeks to determine how belief strength is modified by a presentation of clearly articulated evidence for or against: 1) the physical existence of Bigfoot as a species, and 2) the efficacy of geothermal power as an efficient and renewable energy solution. We will first expose the participants to a ten minute video presentation, set as a lecture format. The video will either be about Bigfoot or Geothermal energy and will discuss good evidence for the topic, or evidence against the topic. We will collect the data regarding our participants' level of certainty about the topics using a questionnaire. Our purpose is to test the hypothesis that experimental manipulations of evidence for and against a topic produce changes in people's beliefs about those topics.

The study will also determine if a lively discussion with a close social contact, about the presentation seen, has an effect on belief strength. Participants will bring a close contact into the lab with them, they will watch the presentations individually on

separate monitors and then they will engage in a 10 minute conversation about the topic. The conversation will be mediated by an experimenter who will attempt to guide them toward comparing and contrasting their viewpoints and evidentiary arguments. Participants will be placed randomly in one of two conditions: they and their contact both received evidence for a belief; one received evidence for the belief and the other against.

We will create separate, equivalent groups for this study as we are planning on conducting between group comparisons. We will use a 2 way analysis of variance to examine group differences in belief strength following these manipulations. We believe that these analyses will provide further insight into the role of evidence and close contacts in the formation and retention of belief. Does positive evidence increase belief strength, increase the number of points of evidence people can offer and increase the rating of the quality of that evidence? In our previous studies we didn't know if belief strength was related to evidence because people believe more strongly in things that they have good evidence for or if they simply produce more evidence for things that they are firmly convicted about. We hope that this study, paired with the methodology outlined in the next section below will help us glimpse aspects of the causal relationships involved.

Objective Assessments of Participants' Evidence

In our past research we have focused on the strong relationship between the amount of evidence that participants can offer for and against a belief, and the ability of the weight of their subjective judgments about the quality of that evidence to predict their own belief strength. We have not; however, sought to measure the objective quality of participants' self-generated evidence. The evidence that participants self-generated could

have been faulty or biased, and it is possible that their beliefs are unwarranted on the basis of the "objective quality" of that evidence, a phenomenon that is thought to be widespread in belief research (Anderson et al., 1990). We believe an important next step in our research is to examine the objective quality of the evidence that participants offer for their beliefs. It is important to point out that even though our present research does not do this, it does have a reliable record of how each subject perceives the quality of their evidence. Furthermore, we know that perceived high quality of evidence turned out to be one of the strongest predictors of belief strength in our data. In other words, we are interested in these measurements but do not think that its omission from Study 1 is a problem for our research focus, given that our goal was to examine the relationship between evidence subjects could offer and their own beliefs. Furthermore, it is not clear that a third parties objective assessment of a person's evidence will be able, or would be predicted, to meaningfully predict variance in that person's belief strength.

We would like to see if people's ratings of the quality of the evidence they were able to produce is positively related to the actual objective quality of the evidence. In order to do this we plan to develop objective, scientific evaluations of the most common forms of evidence offered by participants in response to our past queries for evidence. We have already compiled extensive lists of evidence generated by participants for and against belief in God, gorillas, Bigfoot and women's access to the highest leadership positions. Next we plan to contact experts in these areas and have them rate the quality of the most frequently recurring points of evidence. With these ratings as a measure we can use correlation techniques to determine the extent to which participants' ratings of

evidence quality correlate with those of qualified experts. In other words, we will be able to address the question of whether or not the participants who think they have good evidence, really do, and thus are entitled to feel that they have been objective.

The Influence of Beliefs on Health Behaviors

Better understanding of the determinants of belief should encourage researchers to examine the role that beliefs play in behavior and the relationships between belief strength, behaviors and outcomes. In fact, we think beliefs are important because we think they influence and guide behavior. This led us to examine the relationship between belief strength in the importance of certain health behaviors and the habitual performance of those behaviors. In Study 2, reported next, we examined such relationships in the consequential domain of human weight management. We explored relationships between belief strength in the importance of diet and exercise and the self-reported level of engagement in those behaviors, as well as the relationship between the beliefs and behaviors and the outcome variable of body mass index (BMI).

Chapter 17: Health Beliefs and Their Relationship to Behavior and BMI

Chapter Abstract

This study investigates whether people's self-reported weight management beliefs predicted diet and exercise behaviors and whether these behaviors in turn predicted BMI. These expected results were strongly supported by the data gathered from 996 participants, who responded to a questionnaire, reporting their height, weight, beliefs about various aspects of weight management, and personal weight-management behaviors, including exercise activities and eating habits. Body Mass Index (BMI) and total number of minutes of weekly exercise were computed from the reports. Relationships were found between strong beliefs about the importance of specific health practices and the performance of the practices. More specifically, multiple regression analyses revealed significant relationships between total weekly exercise and belief in the importance of exercise; between total weekly exercise and healthy diet; and between BMI and unhealthy diet. Overall, 40% of the variance in BMI within our sample, including 49% of the variance in BMI in individuals older than 25, could be predicted by a combination of health beliefs and their associated eating and exercise behaviors.

Introduction

Study 1 intended to contribute to previous literature by focusing on specific relationships between belief strength and its determinants. But why should researchers study beliefs unless they relate to important behaviors and behavioral outcomes? Study 2 intended to follow up with the concept of belief strength, to analyze its role in predicting behavior patterns and chose to do this in the important domain of health decision making. To what extent do beliefs about health management affect behavior? Could the behaviors driven by these beliefs actually influence health as measured by body mass index (BMI)? The present study was designed to analyze these questions by determining whether the strength of belief in health-related statements predicts habitual engagement in health related activities and the important health outcome of BMI. We hypothesized that belief in the importance of monitoring weight, maintaining a healthy diet, maintaining a healthy exercise regimen, and maintaining discipline in weight management would all relate positively to healthy behaviors and negatively to unhealthy behaviors and BMI. Conversely, we expected that the belief in the role of genetics as a determinant of weight would show the opposite pattern of relationships.

Identifying the psychological factors involved in effective diet and exercise has long been an area of interest and research (Popkin, 2006). Motivational aspects have been extensively examined as sustained regimens of diet and exercise are known to lead to tangible, health-promoting results. Exercise has been shown to increase both mental and physical health whereas poor diet and sedentary lifestyle have been closely associated with a number of health complications and diseases (Pardo Silva, De Laet, Nusselder,

Mamun, & Peeters, 2006). Health problems that result from or become exacerbated by both improvident eating habits and sedentary lifestyle include coronary heart disease, cardiovascular disease, hypertension, diabetes mellitus, obesity, osteoporosis, and some cancers (Ekelund, Franks, Sharp, Brage, & Wareham, 2007). Consistent regimens of vigorous exercise paired with proper eating habits have been shown to significantly improve self-image (Bowen, Fesinmeyer, Yasui, Tworoger, Ulrich, Irwin, Rudolph, LaCroix, Schwartz, & McTiernan, 2006), cognitive functioning and mental health (Taylor, Sallis, & Needle 1985), as well as symptoms associated with mild to moderate depression (Annesi, 2008); they have also been shown to serve as powerful adjuncts for the treatment of alcoholism and substance abuse (Koeppl, Heller, Bleecker, Meyers, Goldberg & Bleecker, 1992). Furthermore, exercise alone has been shown to reduce symptoms of anxiety, reduce extreme physiological responses to stressors, and palliate aspects of coronary prone (Type A) behavior (Bowen, Fesinmeyer, Yasui, Tworoger, Ulrich, Irwin, Rudolph, LaCroix, Schwartz, &McTiernan, 2006). Despite the benefits of weight management and the significant costs of mismanagement, the prevalence of obesity has reached epidemic proportions in the United States as 75 % of Americans are overweight, 30% are clinically obese, and only 25% of Americans are at a medically healthy weight with a BMI of 25 or less (Flegal, Carroll, Ogden, & Curtin, 2010).

Self-regulation of weight is known to incorporate at least two sub-tasks: self-regulation of diet and self-regulation of physical activity. Although self-regulation and health management have been widely researched and promoted in the United States, most overweight people do not engage in exercise or self-regulatory dietary practices (Kruger,

Yore, & Kohl, 2008). This situation leads to an important question for consideration: Are current programs and methods of intervention targeting appropriate psychological factors?

Given the importance of health self-management, much research has studied the relationship between health-promoting behaviors and demographic, lifestyle, and cognitive factors. Psychologists, exercise physiologists, public health experts, and others have reported on hundreds of controlled studies examining the cognitive factors, including awareness of disease risk (Naslund, 1997), propensity for goal-setting (Macdonald &Palfai, 2008), influence of body image (Paxton, Wertheim, Gibbons, Szmukler, Hillier, &Petrovich, 1991), capacity to self-monitor (Nothwehr & Peterson, 2005), and knowledge of medical recommendations (Morrow, Krzewinski-Malone, Jackson, Bungum, & FitzGerald, 2004). However, research on the relationship between individuals' dietary and exercise behaviors and their personal beliefs about these factors is lacking.

Studies have shown that survey respondents are generally well aware of traditional activities that provide health benefits, but are less aware of specific exercise and lifestyle guidelines (Morrow et al., 2004). Morrow et al. found that accurate knowledge about the benefits of physical activity was not significantly related with exercise activity sufficient for a health benefit. This research as well as the work of others suggests that simply being knowledgeable about healthy exercise behavior is not sufficient to elicit healthy exercise behavior. Based on the understanding that knowledge

alone does not incite healthy behaviors, the present authors speculate that beliefs might play a role in health management even if proper knowledge does not.

Targeting belief may be a more efficient and efficacious way to influence health behaviors than targeting knowledge. It is important to point out that belief is not equivalent to knowledge (Abelson, 1979; 1986; Hay, 2008). Belief is usually described as a psychological state in which a person holds a proposition, perception, inference, judgment, or premise to be true (Green, 1971). Belief is also influenced by factors like self-identity and personal history that do not play commensurate roles in knowledge formation (Reser, 2009). Therefore, in the absence of veridical knowledge, an overly strong belief about benefits of diet or exercise regulation may be highly motivational, although it may be factually incorrect, whereas a belief that downplays the benefits may be an unfortunate handicap. Beliefs come to be accepted and are reformulated differently than knowledge, and past research has targeted belief as a factor in health behaviors. In fact, previous studies have measured the role of belief in certain aspects of medical health management.

Studies on asthma, hypertension, diabetes, and hypercholesterolemia have documented relationships between patient outcomes and beliefs about medical compliance (Lynch, Birk, & Weaver, 1992). Belief in the importance of seeking treatment, perceived benefits of treatment compliance, and perceived seriousness of disease and treatment risks have all been associated with positive results (Chambers, Markson, Diamond, Lasch, & Berger, 1999; Edman, Diamond, Wortman, & Carballo-

Sayao, 2001; King, 1982). Beliefs have also previously been considered, to a limited extent, relative to certain aspects of diet and exercise.

According to the health belief model (Becker, 1974; Rosenstock, 1974), a person will embrace health behaviors if he/she understands the benefits of a particular practice as well as negative consequences from avoiding the practice. The Health Beliefs questionnaire (Diamond, Becker, Arenson, Chambers, & Rosenthal, 2007) is a 15-item instrument measured on a 5-point Likert scale ranging from "strongly agree" to "strongly disagree." It assesses (a) center of control ("Being healthy is largely a matter of good fortune."), (b) certainty ("I am often confused about what to do to stay healthy."), (c) self-awareness of health ("I have an objective perspective on my health."), and (d) importance of health ("I think about my health a lot."). The literature in this area shows that certain beliefs detract from healthy behavior while others promote it. This research has shown that believing that exercise or dieting is unhealthy, risky, or personally irrelevant forms a barrier to exercise and dieting (O'Brien, Cousins, & Gillis, 2005). Individuals also experience such barriers if they believe that they are not athletic, lack confidence or feel embarrassed to be seen exercising, and believe that exercise does not provide much pleasure (Jewson, Spittle, & Casey, 2008). Thus, previous studies have analyzed beliefs concerning barriers to health behaviors and medical compliance, but have not looked at individuals' belief strength in statements about the efficacy of specific health management behaviors and have not looked to see if these can be predictive of actual behavior and health outcomes, such as BMI.

In an effort to gain understanding of the relationships between beliefs and health outcomes, the present exploratory study aimed to determine the relationship between belief strength in self-regulative statements about health behaviors and reported health behaviors and their outcomes. The study focused on five core beliefs we identified in the weight management literature and attempted to determine the correlation between the health beliefs of individuals and their behavior. Furthermore, we sought to use multiple regression analyses to determine whether people's self-reported beliefs in weight management behaviors predict their exercise and dieting behaviors as well as BMI.

Methods

Participants

Participants were student volunteers and their close contacts recruited from a private research university, the University of Southern California (USC). Overall, 996 participants, age 18 or older, participated in the study. Self-reported data was collected online using a Qualtrics survey tool. No personal identifiers were collected. A USC institutional review board application, which requires researchers to meet strict guidelines in terms of protection and confidentiality, was submitted and approved. The participants indicated that they understood and agreed to the details of the study by continuing with the survey after reading an information sheet that described the study, its intentions, and the associated risks (see Appendix C).

Procedure

Participants were given an information sheet with a URL linked to an online questionnaire. The questionnaire (see Appendix D) was designed to identify individual

variability across our participants in BMI, health beliefs, and health behaviors. The survey took approximately 5-10 minutes to complete.

Beliefs Questionnaire

Participants first responded to the demographics section of the questionnaire, which asked participants about their age, gender, level of educational achievement, race, height, and weight. Next, participants were asked to rate five belief statements on an eleven-point scale ranging from -5 to 5, indicating the degree to which they think the statements are either true or false. Participants were asked to mark a -5 if they were confident that the statement is false, a zero if they were not sure, and a 5 if they were confident it is true. The five beliefs considered are listed in Table 18. Participants were asked to read and respond to 11 individual questions about health behavior also found in Table 18. The questions asked participants to respond with numerical estimates.

Table 18: Lists of Questions Responded to with Numerical Estimates

List of Belief Statements

1. Every adult should exercise at a moderate to intense level for at least 30 minutes a day, five times a week.
2. Every adult should eat a healthy, nutritious diet containing lots of fruit, vegetables, and fiber.
3. Every adult should monitor their weight and keep it in a normal healthy range.
4. Managing your weight and keeping it in a healthy, normal range is a practiced skill that requires attention and effort.
5. Genetic factors play a large role in how much a person weighs and make it difficult for many people to keep their weight in a normal, healthy range.

List of Behaviors:

1. How many times a **week** do you perform moderate to intense exercise, such as running, cycling, swimming, basketball, weight training, etc.?

2. How many **minutes** of moderate to intense exercise do you do, in a typical session?
3. How many servings of fruits and vegetables do you eat in a typical **day**?
4. How many servings of fish do you eat in a typical **week**?
5. How many servings of lean meats such as chicken or turkey do you eat in a typical **week**?
6. How many servings of red meat do you eat in a typical **week**?

Table 18, continued

7. How many servings of pork do you eat in a typical **week**?
8. How many servings of desserts do you eat in a typical **week**?
9. How many servings of junk food (potato chips, candy bars, etc.) do you eat in a typical **week**?
10. How many fast food meals (hamburgers, cheese burgers, fries, tacos, etc.) do you eat in a typical **week**?
11. How many regular soft drinks (non-diet, Coke, Pepsi, etc.) do you drink in a typical **week**?

The answers to these behavioral questions were used to construct composite measures. Total weekly exercise for each participant was computed by multiplying the number of reported minutes of exercise per session by the total number of sessions per week. The eating behaviors reported by participants were used to calculate positive, neutral, and negative measures of diet. Positive diet was calculated by summing the total number of reported weekly servings of fruit and vegetables, fish, and lean meat. Neutral diet was computed by summing together weekly servings of red meat and pork. Negative diet was calculated by summing weekly servings of dessert, junk food, fast food, and soft drinks. BMI was determined by taking the weight in pounds, dividing it by height in inches squared, and then multiplying it by a conversion factor of 703 (West, 1980).

The weight and height data were based on self-reports, not on direct measurements. This was a limitation in our study. However, self-reported and measured weight are highly correlated, with a correlation as high as 0.98 (Larsen, Geenen, van

Ramshorst, Brand, Hox, Stroebe, & Doornen, 2006; McAdams, Van Dam, & Hu, 2007), thus the fact that we used self-report data to calculate BMI shouldn't have strongly affected the results.

Results

We collected 1,222 responses to the questionnaire in total. After removing pregnant women (14 or 1.4% of the sample), individuals who reported they had a medical complication affecting their weight (142 or 13%), and individuals whose responses contained data out of the range of plausible values, we obtained 996 valid responses. The average participant was 24 years old (with a standard deviation of 9.3 and median age of 23). The youngest was 18 and the oldest was 80. The sample was 61% female with 662 female respondents. The sample was roughly 60% White, 23% Asian, 7% Hispanic, 4% Black, 2% Indian, 1% Pacific Islander and 3% other. The average number of years of education completed was 14.83. The mean height was 66 inches and the weight was 149 pounds with a standard deviation of 32.3. The mean BMI was 23.6 with a minimum of 16.1 a maximum of 43.8 and a standard deviation 4.2.

Table 19 shows correlations between pertinent variables. The correlations support our hypotheses, indicating that strong beliefs in health statements relate positively with healthy behaviors and negatively with unhealthy behaviors and BMI. BMI correlated negatively with total exercise (-.25), positive diet (-.33), and four health management beliefs (belief in exercise (-.37), belief in healthy diet (-.47), belief in monitoring weight (-.44), and belief that weight management is a practiced skill (-.41)), whereas BMI correlated positively with negative diet (.44), neutral diet (.25), and belief in genetics as a

determinant of weight (.13). The highest correlations seen in the table (.36 to .69) were among the four health management beliefs: the importance of exercise, the importance of a healthy diet, the importance of weight monitoring, and the belief that weight management is a practiced skill.

Table 19: Correlations among All Study Variables

	BMI	Total Exer.	Belief in Exer.	Belief Health & Diet	Belief Mon. Weight	Belief Pract. Skill	Belief Genetics	Pos. Diet	Neut. Diet	Neg. Diet
BMI		-.25**	-.37**	-.47**	-.44**	-.41**	.13**	-.33**	.25**	.44**
Total Exercise			.35**	.24**	.24**	.20**	-.03	.29**	-.10**	-.27**
Belief in Exercise				.45**	.44**	.36**	.02	.16**	-.22**	-.35**
Belief in Healthy Diet					.69**	.65**	.05	.31**	-.13**	-.30**
Belief in Monitor Weight						.66**	.04	.31**	-.11**	-.31**
Belief in Practiced Skill							.08*	.30**	-.04	-.23**
Belief in Genetics								-.17**	.02	.075*
Positive Diet									.15**	-.13**
Neutral Diet										.41**
Negative Diet										

Note. *Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Table 20 shows the betas (βs) and R-square (R^2) changes when beliefs were used as independent variables to predict the dependent variables of health behaviors and BMI in a stepwise multiple regression analysis. The values shown in the cells of Table 20 are: (1) the standardized regression coefficients, βs; (2) the R-square change associated with

the predictor shown in the parentheses; (3) the superscript numbers following the parentheses indicate the order of entry in the stepwise regression. The R-square shown in the last column is the total variance accounted for by the predictors that entered the equation.

Table 20: Stepwise Regression Analyses of Contribution of Health Beliefs on Health Behaviors and BMI.

	B: Exercise	B: Healthy Diet	B: Monitor Weight	B: Practiced Skill	B: Genetics	R^2
Total Ex.	.30(.12)[1]		.11(.01)[2]			.13**
Pos. Diet		.13(.01)[4]	.15(.11)[1]	.13(.02)[3]	-.19(.03)[2]	.16**
Neu. Diet	-.23(.05)[1]					.05**
Neg. Diet	-.25(.12)[1]	-.09(.01)[4]	-.14(.03)[2]		.09(.01)[3]	.17**
BMI	-.17(.03)[2]	-.24(.23)[1]	-.12(.01)[5]	-.14(.02)[4]	.17(.03)[3]	.31**

Note. The values are the standardized regression coefficients, β (R-square change associated with the predictor). Superscript numbers indicate the order of entering in the stepwise regression. The R^2 shown in the last column is the total ratio of variance explained by all the predictors. ** $p < .001$

As seen in Table 20, total exercise was predicted best by the belief in exercise (β= .30 and R^2 = .12) and then by the belief in the importance of monitoring weight (β= .11 and R^2= .01). The positive betas indicated that the stronger our participants believed in the importance of exercise and monitoring weight the more likely they were to report that they engage in regular exercise.

Positive diet was predicted best by the belief in the importance of monitoring weight (β= .15 and R^2= .11), and the relationship was positive. Next positive diet was negatively related with the belief in the role of genetics (β= -.19 and R^2= .03), positively

related with the belief that managing weight is a practiced skill (β= .13 and R^2= .02), and finally, positively related with the belief in healthy diet (β= .13 and R^2= .01). Neutral diet was only predicted by belief in exercise (β= -.23 and R^2= .05). The negative beta here indicated that as the belief in the importance of exercise increases, the less red meat and pork is consumed.

Negative diet was predicted best by the belief in exercise (β= -.25 and R^2= .12). This relationship was negative indicating that the higher the belief in exercise, the lower the consumption of unhealthy foods. Negative diet was also predicted by the belief in the importance of monitoring weight (β= -.14 and R^2= .03), the belief in genetics (β= .09 and R-square = .01), and finally the belief in healthy diet (β= -.09 and R^2= .01). These results show that the less participants believed in the importance of exercise, monitoring weight and healthy diet, and the more they believed in the contribution of genetics, the more unhealthy food they reported to consume.

BMI was predicted best by the belief in a healthy diet (β= -.24 and R^2= .23) followed by the belief in exercise (β= -.17 and R^2= .03), the belief in genetics (β= .17 and R^2= .03), the belief that weight management is a practiced skill (β= -.14 and R^2= .02), and the belief in the importance of monitoring weight (β= -.12 and R^2= .01). The results of these stepwise multiple regressions are highly consistent with our predictions, and provide further understanding of the unique variances explained by the pattern of simple correlations shown in Table 19.

As Table 20 shows, the belief in the importance of exercise entered into the equation first in three of the five regression equations, those predicting total exercise,

neutral diet, and negative diet. The beta between belief in the importance of exercise and total exercise performed was positive (.30), as we predicted. Similarly as predicted, the beta was negative between the belief in the importance of exercise and BMI (-.17) and both neutral (-.23) and negative (-.25) dietary habits. The beta for the belief in genetics was exactly the opposite of those found for exercise. The beta for belief in genetic determinants of weight was negative for positive dietary habits (-.19) but positive for negative diet (.09) and BMI (.17). Aside from the belief in the importance of exercise, neutral diet was not predicted by any other belief and it had the lowest, albeit significant, R-square of .05. The regression equation using beliefs to predict BMI accounted for the most variance. Table 20 shows that 31% of the variance in BMI can be predicted directly from the five beliefs we chose for this study. Each of these beliefs makes a unique, significant contribution to the total R-square.

In the next stage of our analysis, we examined the extent to which health behaviors predict BMI. The results in Table 21 show that the behaviors reported by our sample did predict BMI and accounted for 28% of the variance. Table 21 shows that negative diet entered first into the regression equation (β= .32 and R^2= .19), followed by positive diet entering second (β= -.29 and R^2= .07), neutral diet entering third (β= .15 and R^2= .02), and total exercise entering last (β= -.10 and R^2= .01). The valence of these betas closely corresponds with our predictions. Negative dietary practices predicted larger BMIs and positive dietary practices and exercise predicted smaller BMIs.

Table 21: Stepwise Regression Analyses of BMI on Behavioral IVs

	Neg. Diet	Pos. Diet	Neu. Diet	Total Exercise	R^2
BMI	.32(.19)[1]	-.29(.07)[2]	.15(.02)[3]	-.10(.01)[4]	.28**

Note. The values in the table are standardized regression coefficients β (the R-square change associated with the predictor). Superscript numbers indicate the order of entering in the stepwise regression. The R^2 in the last column is the total ratio of variance explained by all the predictors. ** $p < .001$

Table 22 shows the results of regression analyses performed with BMI as the dependent variable and each of the beliefs and behaviors allowed to enter as independent variables. When comparing this Table with Tables 20 and 21, it is clear that some variables drop out of the equation when beliefs and behaviors are entered together. In fact, Table 22 was constructed to investigate if beliefs and behaviors are unique and additive determinants of BMI or merely overlapping predictors. Table 22 shows that BMI was predicted best by belief in a healthy diet (β= -.20 and R^2= .23), followed by negative diet (β= .23 and R^2= .10), positive diet (β= -.17 and R^2= .03), neutral diet (β= .13 and R^2= .01), the belief that weight management is a practiced skill (β= -.15 and R^2= .01), the belief in the role of genetics (β= .11 and R^2 = .01), and the belief in exercise (β= -.10 and R^2= .01). When both beliefs and behaviors were allowed to enter the regression equation together, they accounted for 40% of the total variance in BMI. In other words, together they account for 9% more variance in BMI than either accounted for alone. There is considerable independent variance in BMI being predicted by beliefs and behaviors – they are not complete proxies for each other.

Table 22: Stepwise Regression Analyses of BMI on all IVs.

	B: Healthy Diet	Neg. Diet	Pos. Diet	Neu. Diet	B: Practiced Skill	B: Genetics	B: Exercise	R^2
BMI	-.20(.23)[1]	.23(.10)[2]	-.17(.03)[3]	.13(.01)[4]	-.15(.01)[5]	.11(.01)[6]	-.10(.01)[7]	.40**

Note. The values in the table are standardized regression coefficients β (the R-square change associated with the predictor). Superscript numbers indicate the order of entering in the stepwise regression. The R^2 in the last column is the total ratio of variance explained by all the predictors. ** $p < .001$

Supplementary Analysis

There was very little inter-individual variability for many of the variables in our sample. For instance, most participants had very low BMIs; however, older participants had more variability in BMI. Overall, 742 individuals were younger than 25 years old and 253 individuals were older than 25. For individuals under 25, the mean BMI was 23.23 with a standard deviation of 3.98 (with a minimum of 16.10 and maximum of 41.73). For individuals 25 and over, the mean was 23.80 with a standard deviation of 4.70 (with a minimum of 17.54 and maximum of 43.92). This difference in standard deviation, 3.98 versus 4.70 motivated us to repeat the same regression analyses for the older group. Knowing that low variability in the dependent variable decreases statistical power in regression analyses, we decided to redo the regression equations using the 253 members who were older than 25 years. The results are summarized in Tables 23, 24, and 25. the betas and the R-square values were higher in the older group.

Table 23 shows the same analyses as Table 20 but was conducted with older participants. The beta and R-square values are higher for this sub-sample. The total R-square predicting exercise behavior from beliefs increased from .13 for the total sample

to .19 for the 253 participants who were over 25 years of age. Similarly, the total R-square predicting positive diet from beliefs increased from .16 to .19 for the older sample. The total R-square predicting neutral diet from beliefs increased from .05 to .18, and the R-square for predicting negative diet from beliefs increased .17 to .24. Similarly, the total R-square for predicting BMI from beliefs increased from .31 to .40 for the older sample, alone. Aside from the magnitude of the findings, the general pattern of relationships is the same.

Table 23: Stepwise Regression Analyses of Contribution of Health Beliefs on Health Behaviors and BMI for Individuals over 25.

	B: Exercise	B: Healthy Diet	B: Monitor Weight	B: Practiced Skill	B: Genetics	R^2
Total Ex.	.30(.15)[1]	.14(.02)[3]			-.15(.02)[2]	.19**
Pos. Diet		.18(.02)[3]	.20(.13)[1]		-.21(.04)[2]	.19**
Neu. Diet	-.37(.18)[1]					.18**
Neg. Diet	-.36(.20)[1]		-.22(.04)[2]			.24**
BMI	-.26(.10)[2]	-.19(.02)[3]		-.30(.27)[1]	.14(.02)[4]	.40**

Note. The values are the standardized regression coefficients, β(R-square change associated with the predictor). Superscript numbers indicate the order of entering in the stepwise regression. The R^2 shown in the last column is the total ratio of variance explained by all the predictors. ** $p < .001$

The findings in Table 24 (reporting on the sample of individuals 25 and over) are very similar to those in Table 21 but show that the beta and R-square values are considerably higher in individuals over 25. Tables 21 and 24 both show that positive diet, negative diet, and exercise behaviors significantly predicted BMI. In the older sample,

however, these three variables accounted for 37% of the variance in BMI, whereas they only accounted for 28% of the variance in the total sample.

Table 24: Stepwise Regression Analyses of BMI on the Behavioral IVs for Participants over 25.

	Neg. Diet	Pos. Diet	Total Exercise	R^2
BMI	.46(.31)[1]	-.18(.04)[2]	-.15(.02)[3]	.37**

Note. The values in the table are standardized regression coefficients β (the R-square change associated with the predictor). Superscript numbers indicate the order of entering in the stepwise regression. The R^2 in the last column is the total ratio of variance explained by all the predictors. ** $p < .001$

Tables 22 and 25 show the regression equations in which both behavior and beliefs were jointly entered to predict BMI for the total and over 25 subsample. A comparison of Tables 22 and 25 shows individuals younger than 25 differed from individuals older than 25 in terms of the order in which variables entered into the equation and in terms of which variables did and did not enter the equation. Also there was a considerable difference in the total variance accounted for: When beliefs and behaviors entered the regression equation together, the independent variables accounted for 40% of the variance in BMI for the total sample (see Table 22), whereas a similar set of variables accounted for 49% of the variance in BMI for individuals over 25 years of age (see Table 25).

Table 25: Stepwise Regression Analyses of BMI on All IVs for Individuals Over 25

	Neg. Diet	B: Practiced Skill	Total Exercise	B: Healthy Diet	B: Exercise	R^2
BMI	.33(.31)[1]	-.26(.13)[2]	-.12(.03)[3]	-.14(.02)[4]	-.12(.01)[5]	.49**

Note. The values in the table are standardized regression coefficients β (the R-square change associated with the predictor). Superscript numbers indicate the order of entering in the stepwise regression. The R^2 in the last column is the total ratio of variance explained by all the predictors. ** $p < .001$

Discussion

This study intended to address and quantify the influence of 5 core beliefs on habitual engagement in diet and exercise. We hypothesized that belief in the importance of monitoring weight, maintaining a healthy diet, maintaining a healthy exercise regimen, and maintaining discipline in weight management would all relate positively to healthy, self-regulative behaviors and negatively to unhealthy behaviors. We also expected that healthy behaviors would relate negatively to BMI and that unhealthy behaviors would relate positively to BMI. The findings supported our predictions: Health management beliefs were found to be strong predictors of health behaviors, which in turn were strong predictors of BMI. When all of the variables were allowed to enter into a regression equation together, health beliefs and behaviors captured 40% of the variance in BMI. To our knowledge, this is the first time that belief strength has been shown to be strongly predictive of diet, exercise, and health outcomes. Furthermore, the predictive value of these beliefs highlights their importance as psychological factors in the modern obesity epidemic.

The results were highly consistent with our hypotheses, and also remained highly consistent with each other in terms of the direction of the betas and the magnitude of the

R-square changes. The relationships found in the simple correlation matrix largely coincided with those found in the multiple regression analyses and the individual regression analyses were highly consistent with one another. As predicted, the belief in the role of genetics related negatively to positive health outcomes and positively to negative health outcomes and BMI. The other four beliefs exhibited the opposite pattern in a manner that was consistent throughout the analyses. In other words, beliefs in the importance of exercise, healthy diet, weight monitoring, and practiced skill positively related to total exercise and positive diet but inversely related to negative diet and BMI. Furthermore, multiple regression analyses revealed that the three most significant relationships were between BMI and unhealthy diet, between total weekly exercise and belief in the importance of exercise, and between total weekly exercise and healthy diet. These findings indicate that belief in the negative impact of an unhealthy diet and belief in the importance of exercise may be among the most important psychological factors for health intervention strategies to tackle.

Table 19 shows that every variable we measured, the five beliefs and four behaviors, were all significantly correlated with BMI, suggesting that all beliefs and behaviors chosen in this study can be taken to predict BMI. The multiple regression analyses show that many of these variables share considerable variance in common, and thus, compete with each other to enter into the regression equations. Table 19 though, demonstrates the high intercorrelations among the predictors. The highest correlations were found among three health beliefs; specifically, a correlation of .688 was found between the belief in the importance of a healthy diet and the importance of weight

monitoring, a correlation of .646 was found between the belief that weight management is a practiced skill and the belief in the importance of a healthy diet, and a correlation of .656 was found between the belief that weight management is a practiced skill and the belief in the importance of weight monitoring. These highly significant correlations suggest that the four health management beliefs were highly interrelated, creating a "health-conscious lifestyle factor." Belief in genetics was uncorrelated with these beliefs and again, consistently showed the opposite pattern of relationships.

Both Tables 20 and 23 support our prediction that the beliefs of our participants predict their behaviors. Tables 21 and 24, in turn, support our prediction that weight management behaviors predict BMI. Tables 22 and 25 show that a combination of health beliefs and health behaviors, when taken together, are strong predictors of BMI. Interestingly, the variables in Table 25 accounted for approximately 9% more of the variance in R-square (R^2= .49) than variables in Table 22 (R^2= .40), demonstrating that - for people over the age of 25 - these factors are better predictors of BMI. This increase in R-square may be attributable to higher variance in BMI within the older group. There may have simply more variance to predict. Another interpretation of this result may be that the longer you live, the longer the cumulative consequences of your health beliefs and health behaviors on BMI and the 25 and older group is reflecting this effect.

Study Limitations

There are a number of limitations that should be addressed. First, there is a debate as to whether conscious thoughts can guide behavior. Some researchers argue that conscious thoughts—such as beliefs—can't influence behavior and claim consciousness

is an epiphenomenon (Dijksterhuis, Chartrand, & Aarts, 2007; Wegner, 2003; Wilson, 2004; Wyer & Bargh, 1997). Others argue that conscious thoughts can cause behavior (Bandura, 1995; Locke, 1995), and there is empirical evidence demonstrating conscious causality (for review see Baumeister, Masicampo, & Vohs, 2011). To the extent that conscious thoughts can guide behaviors, our research shows that health beliefs may be a powerful determiner of health behaviors, and ultimately BMI.

A second limitation is that we are unsure how health beliefs and health behaviors are related. We believe that strong health beliefs motivate healthy behaviors; however, there are other possible interpretations. The relationship may be in the opposite direction; people who participate in healthy behaviors might be more likely to report them as important (Festinger, 1957). It is also conceivable that the relationship is reciprocal: health beliefs and behaviors simultaneously influence one another (Infurna, Gerstorf, & Zarit, 2011; Lachman, 2006; Skaff, 2007). Finally, a third variable, such as genetics, may be mediating the relationship between health beliefs and health behaviors.

There is evidence in support of our opinion that health beliefs are driving behavior. For instance, Infurna, Gerstorf, and Zarit (2011) found that health beliefs precede health outcomes. Using a bivariate dual change score model, they found that perceived control—the belief that one has control over their environment—predicted changes in health, but found no evidence that health predicted perceived control. More research is needed on the particular health beliefs used in this study to determine how they relate to health behaviors.

Despite these limitations, health beliefs predicted a large amount of variance in BMI and health related behaviors, and constitutes an interesting new avenue of research. To the extent that these beliefs can be changed, it may offer a new strategy for increasing motivation to self-regulate behavior.

Conclusions

The results highlight the importance of people's health beliefs about weight management in shaping their weight management behaviors, and in turn, their BMI. The data suggest that belief in genetics as a determinant of weight may detract from certainty in the other beliefs, be self-limiting and demotivational, and should perhaps be downplayed in public communication. However, the other beliefs, especially the belief that keeping a healthy weight is a practiced skill, appear to be empowering and should be promulgated in health promotion efforts and programs.

Undoubtedly, the current epidemic of obesity and general metabolic disease is largely a product of our modern environment (Flegal, Carroll, Ogden, & Curtin, 2010). Artificially high levels of sugars, fats, and processed foods along with sedentary behavior make us more susceptible to obesity today compared to our hunting-and-gathering evolutionary ancestors. It will not be easy to restructure the modern environment without restructuring people's beliefs. If all people strongly believed in the four positive beliefs concerning weight management featured in this study and were disinclined to espouse the belief in the role of genetics, consumer choices and market forces would inevitably precipitate a global reengineering of our current "obesogenic" conditions.

Yet how can belief strength in the positive notions about diet and exercise be increased in the general population? Perhaps this can be done if people are given clear, quality evidence for these beliefs, the beliefs feel permanent, likeable and relevant for them and they were inculcated early, by their parents, to espouse proper notions regarding diet and exercise. Study 1 showed that the estimated opinions of parents,' quality of empirical evidence and importance to self-identity worked together to account for variation in strength of certainty. That study examined the reasons that people use to justify their beliefs and found that, for most people, beliefs are justifiable and closely related to the beliefs of their personal contacts. Study 2 found that people's beliefs closely predict behavior patterns and even the outcomes of those behaviors in the domain of health management. It is probable that this is true of beliefs in other important domains such as how to: save money, parent children, maintain proper hygiene, remain ethical in the face of adversity and foster personal happiness. Together Studies 1 and 2 reinforce previous research and speculation, with new empirical data - long missing in this area of research, about belief and its guiding role in human life.

Belief is distinct from knowledge, memory, and attitude and can be affected by factors such as persuasion, social contacts, self-identity, and personal history (Schacter & Scarry, 2000; Reser, 2009). The key aspects involved in the formation of enduring and actuating beliefs are early inculcation (Anderson & Sechler, 1986; Argyle, 1997), repetitious exposure (Kilbourne & Pipher, 2000), involvement of parents and significant others (Sigel, 1992), expected permanence, perceived relevance, and personal likeability (Paglieri, 2005; Reser et al., 2011). Intervention programs that target belief strength and

focus on these avenues toward persuasion and psychological certainty should achieve significant results in the effort to promote better diet, increased exercise, and healthier lifestyles.

Chapter 18: Final Conclusions

"Whatever we learn has a purpose and whatever we do affects everything and everyone else, if even in the tiniest way… And it's much the same thing with knowledge, for whenever you learn something new, the whole world becomes that much richer."
- Norton Juster

Practically all human thinking involves belief, a modified version of a belief, or a cogitation that can be reframed as a type of belief. For this reason, it is very difficult to give a comprehensive treatment to belief unless one is willing to give a comprehensive overview of cognitive psychology. It seems that by using an interdisciplinary approach, we have uncovered a great deal about beliefs in a short time. Beliefs, although often vaguely defined in discourse, can be conceptualized in many different ways: as associative memories; as coactivations between multiple neural assemblies; as functional cognitive instruments; as self-propagating entities that parasitize minds; as the firings of a certainty module in the brain; as placeholders for self-identity; or as means by which to make sense out of the world. Not only is the concept of belief multifacted but it is also multifactorial, meaning that beliefs can be affected by a large number of different factors. Evidence, rationale, intuition, attitude, persuasion, friends, family, authorities, the social community and the importance to self-identity all make unique contributions to how, and how much, we believe. Other concepts that have proven helpful in the endeavor to explicate the origins and dynamics of belief include personal epistemology, how beliefs can go wrong, delusional thinking, the neuroscience of belief, the ontology of belief, the analogy with déjà vu and speculation about the evolutionary pressures on belief accuracy.

Despite the fact that it is not clear how much of what we have considered can be reconciled, it does seem clear that much of what we have considered is not incompatible or contradictory. The viewpoints we have garnered, although they come from disparate fields, appear to interface in many ways and taken together, paint a rich portrait of the mechanics of belief.

We have come to see that belief, knowledge, memory and attitude are very different and yet tied together inextricably. At this point, we can practically define belief in terms of knowledge, memory and attitude. Belief, it seems, is a type of metaknowledge, or knowledge that particular knowledge is useful and trustworthy. A belief may also be thought of as a type of knowledge that is resistant to correction or modification by subsequently learned knowledge. Because an attitude is a position or leaning on a subject, it seems reasonable to claim that a belief could also be conceptualized as an attitude about knowledge. Further, memories can be seen as beliefs about past events and beliefs can be seen as composed of and reinforced by memories. Redefining beliefs in this way is instructive but many facets of the meaning of belief cannot be captured by these formulae.

Belief seems to imply a state of metapsychological awareness more so than memory, knowledge or attitude and seems to relate that the bearer must be, in some way, aware of their belief in order for it to be a belief. Some of the most common ways to be aware of a belief are to: be aware of its effect on your behavior or thought; be cognizant of the fact that you selected this belief among competing beliefs; or realize that other people may hold a belief that is an incompatible alternative to yours. It is hardly a belief

if you are not aware of it in some way, whereas, knowledge, memories and attitudes can be held without any awareness. Surely, there are many potential ways to be aware of a belief, not all of which involve full or objective appraisal. What kind of metapsychological appraisal must occur, if any, for trusted knowledge to qualify as belief has remained unclear. In fact, much has remained unclear about the ontology and semantics of belief.

Because the word "belief" has never been operationally defined, many other words can be used interchangeably with it. Until a more clear synthesis of work on belief emerges, it will be difficult to discern the difference between belief and similar words like knowledge, attitude, apperception, conception, assumption, conviction, impression, opinion, presumption, supposition or understanding. If anything, belief seems to evoke – more so than these other words – connotations of faith, personal investment and hope. To some, issues like these are of utmost importance in understanding beliefs, to others they are linguistic and pedagogical (Audi, 1988). Semantic issues like these have not been prominent in the present discussion but may help to contribute eventually to a well-rounded understanding of belief formation and change. Here, instead, we have relied on the literature on predictors of belief, and mistaken belief, to help inform this understanding.

Knowledge structures are filled with holes. People are inquisitive and determined enough to want to fill in the holes that they are able to notice, even if they can only do so with guesswork. This is partly because we crave the feeling of certainty. People adopt beliefs often because they feel that, for emotional reasons, they need an answer and they

are willing to convince themselves of something that they are not totally sure about. Too often, we believe something because we want it to be true and not because we know it to be so. This effect is especially problematic because many people have trouble discerning the difference between what they want and what they know. When wish fulfillment plays a large role in the existence of a belief, it is usually not subjected to judicious criticism and it is often protected with the use of defense mechanisms. It is curious that we have a strong propensity to shield beliefs from and impose beliefs on others; even ones that we have not exposed to thoughtful critique.

People must realize on their own, at least to some degree, that they have a limited capacity for analysis, that they are susceptible to making cognitive mistakes and that they are not appropriately informed to make all of the decisions that they would like, about what to believe. When people realize that they do not have the substantiation necessary to formulate a belief, they generally do one, or a combination, of three things: search for evidence, attempt to think rationally or search for an authority. The trouble with this is that people do not do these things exhaustively; they often proceed sloppily and hastily. The tendency to make use of heuristics, to skim, to wing it and to use a finite amount of reasoning inevitably leads to mistakes. Unfortunately, we are never formally taught how to identify these mistakes or how to compensate for them. Courses in logic and critical thinking are rare in high school and can often be misguided in college (Paul, 2005). Without the fundamentals it is difficult for many adults to discriminate between justified contention and specious sophistry. To compound matters, our innate neurological belief system is susceptible to haphazard associations and contaminated inferences. In our

ceaseless attempt to discover meaning, we connect the dots in ways that they were not meant to be connected, and we have a tendency to become fixed in comfortably familiar or just-plain-wrong frames of mind.

People use beliefs inflexibly and apply established beliefs to situations that appear like something they have seen before, based on superficial and irrelevant similarities. Much of what we know about the world is drawn from inferences based on prior probabilities. Often the concepts invoked to make these inferences - the nodes that are primed or coactivated to determine the prior probability - are unrelated to the true factors involved in the causal process. This type of thinking creates a false reality, which can lead to superstitious, inefficient behavior or to drastic consequences. A tendency for forming rash and unsubstantiated beliefs can become habitual, especially when no negative consequences of this tendency are imposed by the environment.

When there are inconsistencies between what people believe and what they experience, this is an indication that their existing world view is not accurate and that they must question their belief (Kelman & Baron, 1968). It is too bad we have a tendency to ignore these inconsistencies (Abelson, 1986a). It is also unfortunate that we have a tendency to inherit these inconsistencies, and even individual beliefs caused by them, from our parents.

However, all is not lost, because the simple use of the term belief can be redemptive. It is customary for people to refer to their working assumptions as beliefs, even if they hold the assumption very dear. The term is an admission of doubt and

because it is honest and self-deprecating, use of it can be forthright, virtuous and empowering.

Beliefs can be empowering in many other ways. Beliefs steer everything from simple behaviors to decision making to goal-directed activities. Belief in religion gives people transcendental comfort; belief in a cause provides purpose and meaning; belief in placebo or medicine creates substantial therapeutic benefits; belief in others results in sociability, camaraderie and intimacy; and belief in one's self drives dedication, discipline, and ultimately, prosperity. It is clear that the ability to believe is essential to being human and can be highly adaptive in many contexts.

It seems humans may have been naturally selected to form certain types of beliefs effectively but not others. We are prepared to believe things that involve foraging activities, tool making and primitive social exchange. Relative to the ancestral past, few of our beliefs today are related to testable strategies and more of them are related to higher-order concepts that are difficult for a single person to falsify. In the modern world, much of what we believe is not directly observable and most of the beliefs that we entertain in day-to-day thought were not acquired first hand but from friends, teachers, books or the media. This process, on a large scale, functions well and clearly enables us to create elaborate cultural and technological advancements that would have been impossible if everyone demanded first-person experience for every belief. On a smaller, personal scale though, we formulate our beliefs within a world very different from that we evolved to believe within and because of this our feeling of certainty might be

miscalibrated. It, in fact, may predispose us to being more naïve and credulous than our wits should allow us to be.

This evolutionary or historical perspective gives us valuable insight into how better to understand other people's reasoning about beliefs, the explanatory relationships among them or the lack thereof. Such an understanding of beliefs can influence us to have a more compassionate outlook on those that hold beliefs that are different from ours. It should also help us identify sociologically accepted paradigms that need more reality testing and areas of human inquiry that deserve more thought and rumination. They may be the most difficult to change but cultural beliefs that are based on emotions like fear, desire, hate or excitement may be the ones that most desperately need to be reconsidered.

Most people have belief systems that are not founded entirely on facts about reality. This is true because so many of us remain very much uninformed about the causal processes that control the world around us. It can be argued that better understanding of these processes affords an individual increased confidence, a more profound sense of self-awareness and a more sophisticated vantage point. The best way to come to understand these processes is to identify matters of importance and then to search for credible documentation on these matters. Initiating and organizing such searches is not always easy, even for intelligent and inquisitive people. Not only can evidence be difficult to unearth but it can also be difficult to identify consequential issues to consider, contemplate and believe in. This is especially so today because commercial media attempts to convince us that trivial and transient things are important. To be introduced to new, interesting information that will embellish and enrich one's worldview is time

intensive and probably involves discriminative television watching, discerning friendship and dedicated reading.

It can be very difficult for people to alter their fundamental beliefs about the world. This is partly because, as the pertinent literature has shown, many people are dogmatically protective of their ideological systems and derive much of their own sense of identity and security from them. Also, people cling tenaciously to their beliefs due to the fact they have been formulating many of them since they were very young. Heavily elaborated beliefs become ingrained in the psyche. Ideas radically different from longstanding beliefs can be threatening, confusing and difficult to compensate for.

Most people do not want to engage in the mental work involved in accepting a new idea because it can be a very difficult task. The more fundamental the belief, the more difficult it is to replace because it is likely to be interrelated with other beliefs that may be contingent upon it. Unconscious, automatic brain circuitry, which is programmed by repeated, habitual actions, is involved here. The more a belief is invoked, the more ingrained it becomes, the more likely the brain is to trust it and use it unquestioningly. Once we routinize the automatic schemas, perceptual associations and emotional concomitants implicitly attached to a familiar belief it may become very difficult to reevaluate or even question them. Questioning a belief requires working memory, time and cognitive resources, and it is clear that, as the cognitive misers that we are (Fiske & Taylor, 1991), humans are reluctant to do this.

In addition, one cannot expect a modified belief to inform decision making in every applicable situation. A new belief must be applied consciously and intentionally

under various circumstances until it gradually becomes implicit itself. Thus, embracing a new belief often involves two things: changing many previous, related beliefs, and reprogramming unconscious reactions. Viewed in this way, new beliefs seem discrete and isolated from those already established and regularly instituted. Belief formation and change then, are gradual, thought-intensive processes that create continuity and integration. This leads us to propose that beliefs are estimations of certainty that people formulate when a situation deems it necessary and this formulation is not based on a comprehensive review of pertinent information, but rather based on whatever criteria happen to come to mind at the time.

If the reader is anything like the present author, a good deal of this literature on beliefs resonates with their own experiences of believing. Looking back years ago, I have a hard time believing how convinced I could be of certain things with only shreds of supporting evidence. I was especially gullible about things that were tied up with my self-concept. Now I know to take precaution with beliefs that involve my ego because my neurological systems may be poorly prepared to deal equitably with these. I also take extra care with beliefs that I borrowed from others without analyzing them on my own.

Overall, I feel that the most important thing that I have learned about beliefs is to question my feeling of certainty. Like many emotions, feelings of certainty can be aroused involuntarily. Just because this unwilled, unthinking sensation has proven trustworthy and dependable in some situations does not mean that it is unimpeachable and can be relied on without reservation. It may not be coincidental that because the preparation of this manuscript has caused me to undergo extensive personal, epistemic

inquisition of my feeling of certainty, that I now feel like I am certain much less frequently and like my beliefs are less egocentric, less intense and overall less polarized.

This review was not meant to instruct the reader as to what to believe, but was meant to show a little about how to believe and hopefully how to think about belief. To summarize the previous conclusions about how to believe, it seems advisable to:

- Reconsider propositions a few times before exercising belief in them
- Consider beliefs as subjective knowledge
- Take note of the context within which a belief is considered
- Acknowledge that all beliefs should be open to change and modification
- Keep in mind that peers, parents, social consensus and even authorities can be wrong
- Remember that disempowering beliefs can be handicaps and empowering ones springboards
- Be wary of the feeling of certainty and its influence on jumping to conclusion
- Remember that not all questions have verifiable, or even objective answers.

It would be interesting to speculate about how a person's behavior would change if their beliefs could be made more discerning and more objective. One might assume that decision making ability, goal-setting and personal productivity would be positively affected. On a larger scale, one might wonder how personal improvements in fluency, expediency and proficiency in the operations of believing might affect larger institutions such as classrooms, companies, states and nations. Because beliefs either actively or

passively manage almost all human activity we should assume that improved believing should result in more well-functioning behavior - for everyone.

There are certainly many alternative views about how one might conceptualize the field of belief and how it might be situated into larger psychological traditions. This is partly due to the fact that beliefs can be conceptualized, validly, under several different contexts and circumstances. There are clearly many circumstances under which a belief can be formed and many ways that a belief can change. We have come to see that there is not a failsafe algorithmic method to evaluate the validity of a potential belief. Believing is certainly not an exact science, as almost any belief will require the believer to have faith in the estimations of others, in the veridical nature of their perceptions, in the accuracy of their memory and in their powers of reason. It is amazing that this process works as well as it does. People's underlying beliefs about knowing and believing mediate the life-long processes of knowledge-acquisition and knowledge-construction. How this process is executed, constrained by biology, influenced by culture and supervised by consciousness will probably be seen as important considerations for a long time to come.

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Appendix A: Informed Consent for Study 1

University of Southern California Psychology Department
INFORMATION SHEET FOR NON-MEDICAL RESEARCH

The Psychological Foundations of Personal Beliefs: Child's Version

PURPOSE OF THE STUDY
This research study examines the psychological foundations of personal beliefs in both scientific and social domains. Please take as much time as you need to read the information sheet. You may discuss this study with your family or friends. Completion of the questionnaire will constitute consent to participate in this research project.

PARTICIPANT INVOLVEMENT
If you volunteer to participate in this study, you will be asked to complete a questionnaire. All procedures will be done over the Internet. You must be at least 18 years of age to participate.

PARTICIPATION AND WITHDRAWAL
Your participation is voluntary. You may choose to not answer individual questions or stop participating at any time, without penalty.

CONFIDENTIALITY
There will be no identifiable information obtained in connection with this study.
The members of the research team and the University of Southern California's Human Subjects Protection Program (HSPP) may access the anonymous data. The HSPP reviews and monitors research studies to protect the rights and welfare of research subjects.

INVESTIGATOR CONTACT INFORMATION
This research study is being conducted by Dr. David Walsh and Jared Reser, from the Psychology Department at the University of Southern California. If you have any questions or concerns about the research, please feel free to contact Professor David Walsh by phone at 213-740-2275 or email at dwalsh@usc.edu.

IRB CONTACT INFORMATION
University Park IRB, Office of the Vice Provost for Research Advancement, Stonier Hall, Room 224a, Los Angeles, CA 90089-1146, (213) 821-5272 or upirb@usc.edu

Appendix B: Questionnaire for Study 1

Beliefs Questionnaire:

The following questionnaire examines people's beliefs about a few elements of the physical, social and religious world. We estimate that it will take only 30 minutes for you to complete and all of your answers will be anonymous. There are four sections to the questionnaire and each has detailed directions of what we would like you to do. It is important that you complete the four sections in the order in which they are presented, so please don't jump ahead to a latter section before completing an earlier one.

You participation in this study is completely voluntary and you are free to stop participating at anytime, even though you may have initially agreed to participate or you may choose to not answer individual items. However, we will only be able to use your responses if you complete every item and carefully follow directions.

If you have questions about completing any of the items we ask that you first go back and reread the instructions for that section and review the example items. If you are unclear after reviewing the directions, then ask the person who is present and overseeing this study for clarification.

Carol Brown, Jian Li, Edward Lin, Jared Reser and Professor David Walsh of the University of Southern California are conducting this study. Professor Walsh can be reached by phone at 213-740-2275 or email at dwalsh@usc.edu.

Demographics Questionnaire:

Please answer the following questions to provide us with useful information about yourself. Remember, your information will remain completely anonymous, as we are not asking for your name or any other identifying information.. However, we do need to match responses from family members. The last four digits of your family residence phone number will allow us to do this without being able to uniquely identify you.

Last 4 digits of family residence phone: _____

Age: _____

Sex: _____

Years of Education (where a high school diploma is equivalent to 12 years): _____

Academic Major: _____

Please list your top two hobbies/interest areas: _____, _____
(ie: Cars, Science)

Ethnicity: _____

Religious Affiliation: _____

Please answer the following question circling the number that best describes your position:

1. *How well has your education prepared you to think scientifically?*

0	1	2	3	4	5	6
Very Unprepared			Moderately Prepared			Very Prepared

2. *To what extent are you a social person?*

0	1	2	3	4	5	6
Very Unsociable			Moderately Sociable			Very Sociable

3. *How important is religious faith to you?*

0	1	2	3	4	5	6
Very Unimportant			Moderately Important			Very Important

Truth or Falseness of Beliefs.

Below are 3 statements that describe beliefs that some people think are true, while others think are false. We would like you to use the 7-point scale below to indicate the degree to which you think each is either true or false. For example, you would choose the number "0" if you are confident that a belief is false or you would choose "6" if you are confident the belief is true. You would write the number "3" if you think it is equally likely the belief is true or false. You would use other numbers to express your opinion if it is intermediate to our examples. There are no right or wrong answers.

We would also like you to use the 7-point scale below to indicate the degree to which you estimate other people think these 6 statements are true or false. First estimate how your parents might evaluate the statement (an average). Then estimate how your five closest personal contacts (friends, family members or peers) might evaluate the statement (again an average). Also estimate how you think the average American would evaluate it, and finally, how a scientist, or an expert on the topic at hand, would do so.

We have provided two examples of how to use the given scale to evaluate the statements that follow:

0	1	2	3	4	5	6
Confident it Is False			Not sure if True or False			Confident It Is True

Example Belief 1: The sun is the center of the solar system.

You: **_5__**

Parents: **_5__**

Personal Contacts: **_5__**

Average American: **_4__**

Scientist: **_6__**

The person that filled out this example question responded to the "you" line with a 5, indicating that they were relatively confident that the sun is the center of the solar system. They also responded with a 5 for "parents" and "personal contacts." The 4 for the "average American" tells us that they estimate that many Americans are not as confident as they and their family and friends are about this belief. Finally, the 6 for scientist tells us that they think most scientists believe confidently that the sun is in the center of the solar system.

0	1	2	3	4	5	6
Confident it Is False			Not sure if True or False			Confident It Is True

Example Belief 2: The moon is made of Swiss cheese.

You: **_0__**

Parents: **_0__**

Personal Contacts: **_0__**

Average American: **_1__**

Scientist: **_0__**

For this second example it is clear that the person is highly confident that the moon is not made of Swiss cheese and that their parents and personal contacts and scientists would agree. The fact that they entered a 1 for the average American shows that they may not be so confident in the analytical abilities of Americans in general. If you are clear on how to use the 7-point scale to express your confidence in the truth or falseness of beliefs, please proceed to do so for each of the 6 beliefs found on the next 2 pages. If you are not clear, please review the above instructions and examples again.

Please use this scale to evaluate each of the statements that follow:

0	1	2	3	4	5	6
Confident It Is False			Not Sure If True Or False			Confident It Is True

1. Bigfoot or Sasquatch is a large animal found on Earth.

You: ___

Parents: ___

Personal Contacts: ___

Average American: ___

Scientist: ___

2. A Supreme Being or "God" exists in some form.

You: ___

Parents: ___

Personal Contacts: ___

Average American: ___

Scientist: ___

3. Women have extremely limited access to the highest leadership position in society.

You: ___

Parents: ___

Personal Contacts: ___

Average American: ___

Scientist: ___

4. Every American should purchase their own home as early in adulthood as possible

Reasons you use to support your belief:

You: ___

Parents: ___

Personal Contacts: ___

Average American: ___

Scientist: ___

5. Every adult should exercise, from youth to old age, at least 5 times every week for 30 minutes or more, performing a combination of aerobic and strength training activities.

You: ___

Parents: ___

Personal Contacts: ___

Average American: ___

Scientist: ___

Reasons Behind Your Beliefs

We now want you to tell us the reasons you have to support or justify your opinion about the truth and falseness of the 3 beliefs you just evaluated. For some beliefs you may only have reasons that support the truth of the belief, while for others you may have only reasons that support the falseness of the belief. For other beliefs you may have reasons that support both the truth and falseness. Please respond to each statement by writing the reasons you have to support the truth and/or falseness of each belief.

After you list a reason to support your opinion, we want you to also rate how strong you think that reason is "as good evidence". For example, write the number "0" beside a reason you have listed if this reason is quite insignificant, but write the number "6" beside the reason if you think it is very significant evidence supporting the truth or falseness of the belief. Below is an example of how you should use the scales to indicate the strength of the evidence you provided. Note that after each reason is a number in **bold type** that we have entered to indicate how strong we think each reason is as evidence for the truth and falseness of the belief.

Example: *The moon is made of Swiss cheese.*

Reasons to Support the Truthfulness	Reasons to Support the Falseness
I have not been to the moon myself to see that it is not made out of Swiss Cheese. **1**	*Astronauts have been to the moon and have not found Swiss cheese on the moon.* **6** *Lunar landing craft have brought back samples of soil and rock from the moon and no Swiss cheese has been found.* **6**

0	1	2	3	4	5	6
Very Insignificant Evidence			Moderately Significance Evidence			Very Significant Evidence

If you understand what is expected of you, proceed to write in the reasons you have to support the truth or falseness of the beliefs on the next page. Be sure to write a number (between 0 and 6) after each reason you write to indicate how strong you think that reason is.

1. Bigfoot or Sasquatch is a large animal found on Earth.

Reasons to Support the Truthfulness	Reasons to Support the Falseness

Please use this scale to evaluate the quality of your reason as evidence:

0	1	2	3	4	5	6
Very Insignificant			Moderately Significance			Very Significant

Evidence Evidence Evidence

2. *A Supreme Being or "God" exists in some form.*

Reasons to Support the Truthfulness	Reasons to Support the Falseness

Please use this scale to evaluate the quality of your reason as evidence:

0 1 2 3 4 5 6

Very Insignificant Evidence	Moderately Significance Evidence	Very Significant Evidence

3. *Women have extremely limited access to the highest leadership position in society.*

Reasons to Support the Truthfulness	Reasons to Support the Falseness

Please use this scale to evaluate the quality of your reason as evidence:

0	1	2	3	4	5	6
Very			Moderately			Very

Insignificant Evidence	Significance Evidence	Significant Evidence

4. Every American should purchase their own home as early in adulthood as possible

Reasons to Support the Truthfulness	Reasons to Support the Falseness

Please use this scale to evaluate the quality of your reason as evidence:

0 1 2 3 4 5 6

Very Insignificant Evidence	Moderately Significance Evidence	Very Significant Evidence

5. Every adult should exercise, from youth to old age, at least 5 times every week for 30 minutes or more, performing a combination of aerobic and strength training activities.

Reasons to Support the Truthfulness	Reasons to Support the Falseness

Please use this scale to evaluate the quality of your reason as evidence:

0 1 2 3 4 5 6

Very Insignificant Evidence	Moderately Significance Evidence	Very Significant Evidence

Sources That Effect Your Beliefs

We now want you to rate a list of **sources** according to how much they influence your belief about the statements. For example, write the number "0" beside a source if it does not contribute to your belief, but write the number "6" beside the source if it does. Below is an example of how you should use this scale to indicate the strength of each source. Note that before each source in the example is a number in **bold type** that indicates how strongly we think each source supports our belief.

This scale will be used to evaluate the example that follows:

0	1	2	3	4	5	6
Very Insignificant Source			Moderately Significant Source			Very Significant Source

Example Belief 1: The Sun is the center of the solar system.
Reasons you use to support your belief:

_1__ I have personally witnessed this.

_4__ I have seen photos, video, a written report, or other secondary source evidence.

_5__ There is a socio/cultural consensus in support of this.

_5__ The best argument in support of this is rational and logically coherent.

Many authoritative sources maintain this position, such as:

_5__ Scientists

_0__ Political scholars

_0__ Religious leaders

The 1 in the first blank indicates that the person has no personal observations of the sun as the center of the solar system and thinks that personal experience is a weak source of support for the belief. This makes sense, as does the 4 they entered for secondary source evidence, because it is not possible to get outside the solar system to see that the sun is in the center. The 5s indicate that the person is highly influenced by the rationality of the argument for the belief, as well as the social and scientific consensus for it. This person entered 0s for political scholars and religious leaders telling us that they are not influenced at all by the opinions of political scholars or religious leaders on this matter.

If you are clear on how to use the 7-point scale to indicate how you have been influenced by different sources, please proceed to do so for each of the 6 beliefs found on the next 3 pages.

Please use this scale to evaluate each of the statements that follow:

0	1	2	3	4	5	6
Very Insignificant Source			Moderately Significant Source			Very Significant Source

1. Bigfoot or Sasquatch is a large animal found on Earth.
Reasons you use to support your belief:

___ I have personally witnessed that this is true

___ I have seen photos, video, a written report, or other secondary source evidence.

___ There is a socio/cultural consensus in support of this.

___ The best argument in support of their existence is rational and logically coherent.

Many authoritative sources maintain this position, such as:

___ Scientists

___ Political scholars

___ Religious leaders

2. A Supreme Being or "God" exists in some form.

Reasons you use to support your belief:

___ I have personally witnessed that this is true

___ I have seen photos, video, a written report, or other secondary source evidence.

___ There is a socio/cultural consensus in support of this.

___ The best argument in support of their existence is rational and logically coherent.

Many authoritative sources maintain this position, such as:

___ Scientists

___ Political scholars

___ Religious leaders

3. Women have extremely limited access to the highest leadership position in society.

Reasons you use to support your belief:

___ I have personally witnessed that this is true

___ I have seen photos, video, a written report, or other secondary source evidence.

___ There is a socio/cultural consensus in support of this.

___ The best argument in support of their existence is rational and logically coherent.

Many authoritative sources maintain this position, such as:

___ Scientists

___ Political scholars

___ Religious leaders

4. Every American should purchase their own home as early in adulthood as possible

Reasons you use to support your belief:

___ I have personally witnessed that this is true

___ I have seen photos, video, a written report, or other secondary source evidence.

___ There is a socio/cultural consensus in support of this.

___ The best argument in support of their existence is rational and logically coherent.

Many authoritative sources maintain this position, such as:

___ Scientists

___ Political scholars

___ Religious leaders

5. Every adult should exercise, from youth to old age, at least 5 times every week for 30 minutes or more, performing a combination of aerobic and strength training activities.

Reasons you use to support your belief:

___ I have personally witnessed that this is true

___ I have seen photos, video, a written report, or other secondary source evidence.

___ There is a socio/cultural consensus in support of this.

___ The best argument in support of their existence is rational and logically coherent.

Many authoritative sources maintain this position, such as:

___ Scientists

___ Political scholars

___ Religious leaders

Personal Importance of Beliefs.

Now we would like to know more about why you hold the beliefs that you do. This section will ask you to indicate the degree to which your opinion of the 3 beliefs is likeable, permanent and relevant to you as a person. For each belief first enter a T or an F to indicate whether you think the belief is true or false. Then use the 7-point scales to indicate how likeable your opinion about the belief is to you (how agreeable and pleasant the concept is to you), then indicate how permanent your conviction is (how unlikely your stance is to change in the future). Finally indicate how relevant this belief is to you (how important the belief is to your sense of self-identity). Write the number "0" if your opinion is not likeable, permanent or relevant at all, but write "6" if it is very likeable, permanent or relevant. Below is an example of the scale and how to use it to indicate how important each belief is to you.

This scale will be used to evaluate the example that follows:

0	1	2	3	4	5	6
Very Unlikeable Impermanent or Irrelevant			Moderately Likeable Permanent or Relevant			Very Likeable Permanent or Relevant

Example Belief 1: The sun is the center of the solar system.

True or False: __**T**__

Likeability: __**2**__

Permanence: __**5**__

Relevance: __**6**__

The "T" in the first blank indicates that the person who filled out this example believes that the Sun is the center of the solar system. In this example the person wrote a 2 for likeability, they must not find this belief particularly likable, perhaps they would make the Earth the center of the solar system if they could. The person expected that their belief about the sun was unlikely to change in the future and so they wrote a 5 for permanence. Finally, the person believes the sun is the center of the solar system and must find this to be an important organizing principle of how they think about the world around them. Thus, they used a "6" to indicate that the belief is relevant to their sense of self-identity.

Example Belief 1: The moon is made of Swiss cheese.

True or False: __**F**__

Likeability: ***1***

Permanence: ***6***

Relevance: __**0**__

The "F" in the first blank indicates that the person who filled out this example believes that the moon is not made of Swiss cheese. In this example the person wrote a 1 for likeability indicates they are not happy with the belief that the moon is NOT made of Swiss cheese. The person used a 6 for permanence to indicate they are certain to never expect the moon is made of Swiss cheese. Finally, the person used a 0 to indicate the moon NOT being made of Swiss cheese has no relevance to their life. Below is a review of the concepts we want you to consider and rate:

True or False: Whether you think this belief is true or false.

Likeability: How much you personally like your belief.

Permanence: How stable, and unlikely to change, is your belief.

Relevance: How important or relevant the belief is to your sense of self identity.

If you are clear on how to use the 7-point scale to express how likeable, permanent and relevant each belief is to you, please proceed to rate the beliefs on the next 2 pages.

Please use this scale to evaluate each of the statements that follow:

0	1	2	3	4	5	6
Very Unlikeable Impermanent or Irrelevant			Moderately Likeable Permanent or Relevant			Very Likeable Permanent or Relevant

1. Bigfoot or Sasquatch is a large animal found on Earth.

True or False(T/F): _____

Likeability: _____

Permanence: _____

Relevance: _____

2. A Supreme Being or "God" exists in some form.

True or False(T/F): _____

Likeability: _____

Permanence: _____

Relevance: _____

3. Women have extremely limited access to the highest leadership position in society.

True or False(T/F): _____

Likeability: _____

Permanence: _____

Relevance: _____

4. Every American should purchase their own home as early in adulthood as possible

True or False(T/F): _____

Likeability: _____

Permanence: _____

Relevance: _____

5. Every adult should exercise, from youth to old age, at least 5 times every week for 30 minutes or more, performing a combination of aerobic and strength training activities.

True or False(T/F): _____

Likeability: _____

Permanence: _____

Relevance: _____

Appendix C: Informed Consent for Study 2

University of Southern California Department of Psychology
College of Letters, Arts & Sciences, 3551 Trousdale Parkway

INFORMATION/FACTS SHEET FOR NON-MEDICAL RESEARCH

Beliefs About Health and their Affect on Health Behaviors

PURPOSE OF THE STUDY
The purpose of this study is to see if people's beliefs about a healthy weight predict their weight management behaviors.

PARTICIPANT INVOLVEMENT
If you volunteer to participate in this study, you will be asked to complete a questionnaire. You will be asked for demographics information, your beliefs about a healthy weight, and behaviors you use to help manage your weight. This will only take 5 to 10 minutes. All procedures will be done over the Internet. You must be at least 18 years of age to participate.

PARTICIPATION AND WITHDRAWAL
Your participation is voluntary. You may choose to not answer individual questions or stop participating at any time, without penalty.

CONFIDENTIALITY
There will be no identifiable information obtained in connection with this study.
The members of the research team and the University of Southern California's Human Subjects Protection Program (HSPP) may access the anonymous data.

The HSPP reviews and monitors research studies to protect the rights and welfare of research subjects.

INVESTIGATOR CONTACT INFORMATION
If you have any questions please contact Jared Reser (reser@usc.edu)

IRB CONTACT INFORMATION
University Park IRB, Office of the Vice Provost for Research Advancement, Stonier Hall, Room 224a, Los Angeles, CA 90089-1146, (213) 821-5272 or upirb@usc.edu

Appendix D: Questionnaire for Study 2

Beliefs About Health and their Effect on Health Behaviors

Last name of the person that recruited you to take this study: _____

Demographic Information:

1. Age _____ in years
2. Sex _____ male or female
3. Race _____
4. Education _____ years after high school
5. Height _____ in inches
6. Weight _____ in pounds

Beliefs: Please indicate your belief strength in the following beliefs by circling a number from -5 to 5 on the scale.

1. Every adult should exercise at a moderate to intense level for at least 30 minutes a day, five times a week.

-5	-4	-3	-2	-1	0	1	2	3	4	5
Completely False					Neither True nor False					Completely True

2. Every adult should eat a healthy, nutritious diet containing lots of fruit, vegetables and fiber.

-5	-4	-3	-2	-1	0	1	2	3	4	5
Completely False					Neither True nor False					Completely True

3. Every adult should monitor their weight and keep it in a normal healthy range.

-5	-4	-3	-2	-1	0	1	2	3	4	5
Completely False					Neither True nor False					Completely True

4. Managing your weight and keeping it in a healthy, normal range is a practiced skill that requires attention and effort.

-5	-4	-3	-2	-1	0	1	2	3	4	5
Completely False					Neither True nor False					Completely True

5. Genetic factors play a large role in how much a person weighs and make it difficult for many people to keep their weight in a normal, healthy range.

-5	-4	-3	-2	-1	0	1	2	3	4	5
Completely False					Neither True nor False					Completely True

Behaviors: Please indicate your eating and exercise habit by filling in the following blanks with whole numbers.

1. How many times a **week** do you perform moderate to intense exercise, such as running, cycling, swimming, basketball, weight training, etc.? _____
2. How many **minutes** of moderate to intense exercise do you do, in a typical session? _____
3. How many servings of fruits and vegetables do you eat in a typical **day**? _____
4. How many servings of fish do you eat in a typical **week**? _____
5. How many servings of lean meats such as chicken or turkey do you eat in a typical **week**? _____
6. How many servings of red meat do you eat in a typical **week**? _____
7. How many servings of desserts do you eat in a typical **week**? _____
8. How many servings of junk food (potato chips, candy bars, etc.) do you eat in a typical **week**? _____
9. How many fast food meals (hamburgers, cheese burgers, fries, tacos, etc.) do you eat in a typical **week**? _____
10. How many regular soft drinks (non-diet, Coke, Pepsi, etc) do you drink in a typical **week**? _____
11. How many times do you weigh yourself in a typical **month**? _____