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Priming and the brain: an unexpected case of reverse priming with a prologue on the paradox of free will

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PRIMING AND THE BRAIN: A CASE OF UNEXPECTED REVERSE PRIMING
WITH A PROLOGUE ON THE PARODOX OF FREE WILL

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Priming and the Brain: An Unexpected Case of Reverse Priming

With a Prologue on the Paradox of Free Will

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I. PROLOGUE: *THE PARADOX OF THE FREE WILL*

The creation of our sense of agency is critically important for a variety of personal and social processes, even if this perceived agent is not a cause of action. The experience of free will is fundamentally important because it provides a marker of our authorship—what might be called an authorship of emotion.- Daniel M. Wegner

The summer before my junior year of college, I read a book titled *Blink*, by Malcolm Gladwell. Question after question haunted me with every page I turned. I read about priming experiments with an incredulous mind. I could not believe that the mere sight of certain words could influence human behavior so easily. Furthermore, I was amazed that this influence did not even have to reach consciousness. The book described a study in which participants exposed to words related to old age would walk out of a building slower than participants primed with neutral words (Bargh, Chen, & Burrows, 1996). When asked if they had noticed the words, or if they had consciously observed in themselves any changes in behavior, they denied any awareness of the prime or its influence on them. Thus, I became extremely curious about how or why priming works and to what extent it can influence human action. Most importantly, however, I felt that this newly discovered information challenged the way that I understood myself, others, and God. The questions came in as a flood: how many of my actions are really under my control, and how many of them are determined by unconscious processes taking place in my brain? What determines who I am? How much power do I have to influence my own life? Is the question "how ought we to live?" valid if I do not have the power to change my life in the direction of the "ought," but am dependent on external circumstances to

line up and influence my behavior accordingly? What is my role in relation to my brain, my body, and my actions? Where do I draw the line? Is there a line?

I believe most people ponder upon these questions at some point in their lives. Part of the reason is that, daily, we wake to up to a sense of self that we cannot escape. As we lay in bed with eyes struggling to open and ears unfortunately receptive to the annoying sound of our alarm clock, our brain welcomes us back to the world of alert consciousness. We know that our thoughts, which at the time can focus on nothing else but the desire to stay in bed for the next two hours, are responsible for forcing our body out of its comfort and making it perform the duties and goals that we have set out for the day. Our brain, which, without our assistance, faithfully executed its duties while we were lost in the deep world of dreams or complete nothingness, is dependent on our help in order to mobilize our body into meaningful action. Thus, we understand that we have an intimate relationship with our brain, one of partnership and loyalty, and one of dependency and mutual care. Yet, there is also a felt distance or disconnect that drives people to make a distinction between their brain and "themselves."

This perceived disconnect comes from the fact that we do not understand the inner workings of our own brain. It is true that we have learned much about how the brain sends, receives, and processes information through research, but it is impossible to arrive at such findings by mere self analysis. No matter how hard we try to concentrate on the mechanisms by which our brain signals our lungs to breathe, our muscles to contract, or our heart to beat faster, we unfailingly find ourselves in the dark, merely

wondering. Thus, we tend to assign the brain its own identity, separate from ourselves, an identity that comprises everything we cannot understand or fully be aware of. As for us, we confine ourselves to sit in a throne that we cannot locate, a throne that is blind, deaf and mute.

From this perception of ourselves, we derive the concepts of free will, agency, and volition. We assume that, although we cannot control the metabolic processes of our body, we have control over the direction and purpose we give our life. We also believe that we can control certain motor behaviors that make our body as dependent on us for survival as we are on it. We presume that the "lower order" and "automatic" processes are in charge of our brain, but that when it comes to decision-making, goal pursuit, motivation and achievement, we are in full control. After all, as the alarm clock goes off in the morning, will we not lay in bed all day unless we will our body to move and be productive?

The truth is that our sense of self is so dominant that we often fail to realize that our mind and our brain are one. We are not merely the ghost voice that directs our body through life, guiding it to act according to abstract concepts that only we can understand but that the cells, ions, and molecules in our body have no knowledge of. We are more than that; we are more than the thoughts we can hear. We are the decisions that our brain makes when we are not looking, the actions we understand in ourselves and are aware of, and those we do not. We are as much a result of our environment, our genes, and our memory, as we are of the thoughts that we perceive ourselves as generating.

Daniel Wegner (2005) discusses in the book, *The New Unconscious,* that even scientific fields, such as psychology, discretely fail to separate themselves from the perceived notion that the brain and self are separate. Psychology uses terms such as "automatic processes" and "controlled processes" to describe the functions of the brain, but as Wegner suggests, there has to be a "controller" in order to have controlled processes. Who, then, is that controller if not the illusion of a separate self? Are not all processes controlled by the brain, whether they are within awareness or not? But even then, awareness from whom? Along the same lines, Daniel Dennett (2001) argues that "we haven't really solved the problem of consciousness until that executive is itself broken down into subcomponents that are themselves clearly just unconscious underlaborers which themselves work (compete, interfere, dawdle,…) without supervision" (p. 228). He states that consciousness is merely the global accessibility of informational states or processes, and that those processes are, in fact, "underlaborers which themselves work…without supervision" (Dennett, 2001, p. 228). On the question of who the "subject" or "self" is, he agrees with Hurley (2008), and states that "the Self…is not to be located by subtraction, by peeling off the various layers of perceptual and motor 'interface' between Self and World. We must reject the traditional 'sandwich' in which the Self is isolated from the outside world by layers of 'input' and 'output'. On the contrary, the Self is large, concrete, and visible in the world, not just 'distributed' in the brain but spread out into the world" (Dennett, 2001, p. 226). Dennett is suggesting that the self is not an internal homunculus that is directing and controlling our every action and thought, but instead, the self is "spread out into the world" because it is made

up by the world and the world's interaction with the physics and chemistry of our body. As Wegner (2005) suggests, "controlled processes do not start with a controller…they result in one." Thus, both Wegner and Dennett caution us that the idea of an "executive," a "controller," or a "self" cannot be used to explain psychological or neurological processes, but that, instead, the self starts with those processes and can only be explained in terms of them.

Interestingly, the idea that subconscious processes regulate all our behavior (whether they surface to consciousness or not), including higher order and complex behaviors such as goal pursuit, motivation, and decision making, has created a lot of controversy, and it is not well accepted despite the growing amount of research that provides evidence for the validity of the argument. For example, in 1965, Kornhuber and Deecke found that the preparation to act precedes an action by about 800 milliseconds. In 1983, taking it a step further, Libet and collegues replicated this study and tested, in addition, when the decision to act became conscious. They found that the conscious decision to act preceded the action by about 200 milliseconds—600 milliseconds after the preparation for the action had already taken place. They concluded that the decision to act starts unconsciously, but becomes conscious before the action itself, so that we perceive our conscious awareness of the decision to act as the actual cause for the action. Similarly, a recent study showed that the *outcome* of a decision can be detected in unconscious brain activity up to 10 seconds before the outcome reaches conscious awareness (Soon et al., 2008). Clearly, it is plausible that the origin of all our actions and decisions have an unconscious origin. Yet, despite these results and the conclusions

drawn from them, there are many who refuse to even consider that the self could possibly just be the result of multiple unconscious processes, that the self is just an "entity" that is merely informed of the decisions that our unconscious is making, instead of being the generator of those decisions.

Following a logical argument, Dijksterhuis and collegues (2007) state that if we believe consciousness to reside in the brain, then, necessarily, conscious awareness must be a function of other unconscious processes, "except if one maintains the belief of a true 'ghost in the machine'" (p.52). Otherwise, "it would be truly mystifying if behavior *would* start consciously" (Dijksterhuis et al., 2007, p.52). Perhaps, this is what most people cannot accept, that there is *not* a "ghost in the machine." John A. Bargh, a prominent social psychologist in the area of automaticity, attributes our present understanding of the free will to St. Augustine, who used "the concept of free-will to solve the 'problem of evil' -- how an all-good and all-powerful God could permit the existence of evil in the world. (Answer: because people must be free to do good or evil as they choose for there to be a basis for the Final Judgment upon each of us.)" (2009, July 10, para. 2). Thus, the ghost in the machine is essential to some people's understanding of the Christian God, whether that is true Christian dogma or not. Consequently, the idea that consciousness is not responsible for all human behavior might evoke responses such as the one Voorhees had to Dennett's comments about the self, "Daniel Dennett is the Devil…There is no internal witness, no central recognizer of meaning, and no self other than an abstract 'Center of Narrative Gravity' which is itself nothing but a convenient fiction… For Dennett, it is not a case of the Emperor having no

clothes. It is rather that the clothes have no Emperor" (Voorhees, 2000, p. 55-56). In such way, the controversy over consciousness spans everything from the belief that there must be an "emperor" or a "ghost" in the machine, to the belief that all behavior starts unconsciously.

Fully aware that the distinction between automatic and controlled processes may not be as clear as we think it is, psychology and neuroscience have launched themselves into a world of research that further challenges our understanding of human behavior, and perhaps even tips the balance in favor of the automaticity of behavior (for a review on automaticity and its component features see Moors & Houwer, 2007, p. 11-50). Through research using priming, we have found extensive evidence to suggest that concepts that we have always assumed to be under conscious control, such as motivation, goal-pursuit, and achievement, may not be so (Ferguson, 2004). The mere sight of words related to those concepts can change our behavior subconsciously. Thus, getting out of bed in the morning might not rely on our thoughts or will as much as we think it does. The environment that surrounds us is so rich in cues that our subconscious mind may generate an action before we even become aware that we are doing it, if we ever do. Therefore, when automaticity is operating to influence action, the critical element is that the subject is unknowingly influenced by the activation of a concept, and that conscious perceptual or judgmental processes are not involved (Ferguson, 2004; Jefferies & Fazio, 2008). In this way, experiments involving priming require that participants do not suspect that there is a relationship between the priming stimuli in tasks and the subsequent dependent measures (Ferguson, 2004). The experiment described in the book *Blink* is one example.

Another example is a double-blind experiment conducted by Bargh and colleagues (1996) in which participants were told that they were part of a linguistics study and were subsequently primed for the concept of either rudeness or politeness by being exposed to words related to those concepts through a scrambled sentence test. The participants were instructed to find the experimenter, who was out in the hall, when they had completed the scrambled sentence test so that he could give them their next task. However, when the participants came out, the experimenter was engaged in conversation with a confederate who pretended to not understand the instructions to a task. The dependent measure was how long it took the participants to interrupt the conversation. A maximum of 10 minutes was allotted for each participant to either interrupt or not. The results were fascinating: about 80% of the participants in the polite condition never interrupted at all, whereas about 65% of the participants in the rude condition interrupted after an average of 5 minutes, a time significantly shorter than that of the participants in the polite or neutral conditions (Bargh et al., 1996). What makes the results of this study truly fascinating is that the participants reported no effect of the priming task on their behavior and showed no awareness or suspicion of the influence the scrambled sentence test had on their interrupting behavior. Furthermore, when a confederate asked participants to complete a "Survey of Experimental Participants" after the study, which asked the participants to rate the treatment they had received from the experimenter, the results showed that the priming task did not influence consciously made judgments of the experimenter, which then determined behavioral responses to him. Instead, the priming task subconsciously influenced the participants' behavior (Bargh et al., 1996).

Experiments such as the ones mentioned beg the question, what are the powers and limitations of priming? The answer to this question is important to understand the extent of our automatic behavior. Förster and collegues mention in the book "The New Unconscious," that "it seems that nothing can be left that cannot be primed" (Förster, Liberman, & Friedman, 2009). To some degree, Förster is right; a wide variety of concepts have been shown to be primed, including memory, creativity, general knowledge, hostility, and achievement, among others (Bargh et al., 1996; Bargh et al., 2001; Dijksterhuis, Aarts, Bargh & van Knippenberg, 2000; Dijksterhuis & van Knippenberg, 1998; Föster, Friedman, Butterbach, & Sassenberg, 2005). Furthermore, priming is not limited to words only. That is, the experiments mentioned so far have all used words to prime participants, which led to changes in behavior. However, there have also been experiments conducted with *material priming*, which means that, instead of words, participants are exposed to objects that may influence their behavior in a particular way. For example, experimenters can expose participants to a backpack in an unobtrusive and passive manner, and such exposure or priming leads participants to behave more cooperatively than participants in a control group (Kay, Wheeler, Bargh, & Ross, 2004). Thus, objects have the same priming effect as do words explicitly related to the concept being primed.

It follows that, potentially, everything in our lives could be priming us for something. In answer to the question "what have we been priming all these years?" Bargh states that, "perhaps, then, what we have been priming all these years is a role, a conceptual structure that contains not only the nuts and bolts of how to act within a

certain persona, but, at essence, the *perspective* a person in that role would have on the world—the purposes and goals and values that a person, or animal, or even steel rod, would have" (2006, p. 155). If this statement is true, and everything in our environment is a cue for who we should be, how we should act, how we should feel, and what perspective we ought to have on the world, then the next logical step is to investigate the mechanisms by which priming works in the brain in terms of processing multiple and conflicting primes simultaneously, how primes affect behavior, and whether the outcomes are always predictable.

The research experiment that I conducted for this thesis project was doing exactly that, observing what happens when we are confronted with two opposing primes simultaneously and exploring the mechanisms through which priming works in the brain. The results of the experiment were somewhat surprising. I found that priming does not always lead to predictable outcomes, as demonstrated by the fact that, inconsistent with previous research, priming participants to achieve actually led them to perform worse than control participants on a task. On the other hand, priming participants for the goal to give up did not seem to have any significant effect. More importantly, priming participants for both goals simultaneously did not have any effect on the participant's behavior. There are various explanations for such behavioral observations that I will explore in the discussion section; however, further research is necessary to ascertain the validity of those possibilities.

In terms of how priming works in the brain, significant differences in cortical electrical activity were observed between different priming manipulations. However, the

meaning of the changes in activity remains unclear; although priming participants for the goal to achieve alone led them to perform poorly on a task, those participants had a higher level of brain activation than all other participants. Yet, if both primes (achievement and giving-up) were presented simultaneously, the level of brain activity returned to baseline. This means that, even though the giving-up prime did not have any significant behavioral effect on participants, its interaction with the achievement prime in terms of brain activity was such that the increased level of activation of the achievement prime alone was cancelled when the giving-up prime was also present. Some possible explanations are addressed in the research paper, but future studies are crucial in order to decipher the meaning of the obtained results.

The fact that priming does not always lead to predictable outcomes elucidates the complexity of the extrinsic and intrinsic factors that could be acting at any given time to influence human behavior. At the same time, the fact that priming is able to have a significant effect on behavior, whether it is in the direction predicted or not, confirms that our behavior is not always determined by conscious decisions, if ever. Furthermore, one important observation that I made during experimentation is that every single participant had a unique behavior of his or her own. Because I was blind to the participant's condition, I had no way of knowing what words they were being primed with, and I found that my guesses, based on observation, were often inaccurate. That is, sometimes participants would work on the task for a very long period and perform very well, yet they were in the neutral condition, getting primed for neither achievement nor giving-up. Thus, I was reminded of a well known psychology stipulation, which is that research

results only apply to populations and not individuals. Yes, we can say that generally as humans we see or hear things, and we are primed to act accordingly, but as individuals, our behavior becomes somewhat unpredictable, and all trends, correlations, and causations disappear depending on the circumstances and the personal nature of that individual.

Yet, we cannot dismiss the value of research on priming, or any psychological research for that matter. The questions that I had when I started this project come together at this point. One of the ways that Dennett describes consciousness is as the global accessibility of information contributed by "specialist networks with limited powers of information processing" (2001, p.222). In the same way, research on automaticity and human behavior seems to gather and make globally accessible information that, as individuals, we are incapable of processing through mere metacognition. Our own, individual human nature is not and cannot be dictated to us by the results of research experiments. In fact, that is not what research tries to do; the purpose of research is to learn about the *potential* of our nature. Understanding how we make first impressions, what motivates us, how and why we pursue goals is important because, even if those behaviors start unconsciously, we are still able to monitor our actions along the way and, in some cases, correct for unwanted biases or tendencies (Glaser & Kilhstrom, 2005).

Insofar as spirituality and religion are concerned, it may be true that the research on automaticity and priming can challenge our understanding of God. However, I do not believe Dennett is "the devil." Why? Because as much as we like to believe that our

thoughts are the causative agents of the change that we witness around us, we also forget that we spend most of our lives trying to understand why we feel the way we feel, why we act the way we do, and why we do the things we do. In our daily life, these questions seem natural and an overarching theme that follows us throughout development and aging. In fact, we do not hesitate to accept, through our own language, that sometimes we act without conscious awareness, such as when we claim that an idea was a spark of intuition, not originating from our own, explicit thoughts, but coming from sudden inspiration; or the idea that we have "callings" and "vocations" in life, external forces that seem to lead us in one direction or the other, life decisions that "chose us," instead of us "choosing them." Yet, our reaction to statements such as the one that Wegner made about the will being "an illusion," or what Bargh said about how the "will is caused, not free," is usually extremely negative. Could it be possible that we believe in a God that gives us complete and free will and, at the same time, believe in a God that has predestined us for a fate that has already been written? Moreover, are we not aware that we believe in such a God?

So we seem to have encountered a contradiction. Wegner explains that the contradiction arises because the will is a feeling (2002, p. 3). As such, he suggests that the will is "not some cause or force or motor in a person but rather is the personal conscious feeling of such causing, forcing, or motoring" (2002, p. 3). Therefore, we can be selective about how we "feel" about the will. Bargh points out that "people routinely make self-serving attributions about the causes of their behavior. We take credit for the positive things we do (free will), but not for our misdeeds and failures ('I had no choice',

'I was abused as a child', 'I was angry')" (2009, June 23, para. 6). While this may be true, how we "feel" about the will may not always be self-serving. People often, mistakenly, feel guilt about accidents that were unavoidable. Therefore, when it comes to either defining who we are as individuals or trying to understand life in terms of a merciful and all-powerful God, the truth about free-will could, in fact, be a contradiction. The same may be true of the psychological and neurological phenomena that cause our behavior and create our sense of self; a contradiction may be the best answer we have.

Therefore, in order to understand the challenging reality of the research on priming, we must first embrace the contradiction between what our perception is informing us (that we are the agents and causative forces of action) and the reality of what actually is. Priming would not be a successful manipulation if our environment were not essential in informing us who we should be and how we should act. In a sense, then, what Bargh implies when he explains that maybe what "we have been priming all these years is a role…the *perspective* a person in that role would have on the world—the purposes and goals and values that person, or animal, or even steal rod, would have," is a very deep search for meaning—the kind of search that even the cells and ions in our body are doing. Moreover, Wegner suggests that, "perhaps we have conscious will because it helps us to remember and appreciate what we are doing…it helps us to appreciate the difference between a light we have turned on at the switch and a light that has flickered alive without our influence" (2002, p.325). According to these views, not only is our biology already in constant movement in search for meaning, but it recruits our consciousness to mark where our presence may have influenced the world. Regardless,

whether we feel as though we have free will or we accept that outside factors are always influencing the way we behave, the contradiction does not disappear. Our environment is always informing our actions and always signaling us with cues as to who to be at that moment, but as an individual you can be moved from something within and react completely unexpectedly, perhaps through consciousness or not. Thus, we find ourselves the constant witnesses and spectators to our own unique lives. Sometimes we wonder why we do the things we do. Sometimes, as was the case with my research experiment, we wonder why an entire group, who had no communication with each other, showed such a pattern of behavior. In both cases, it is apparent that something greater than ourselves, whether outside or within, moves us through life and, from time to time, informs us of its decisions. Nevertheless, even if our consciousness is just a witness to our actions, and not the actual cause for them, by witnessing our own lives we undoubtedly change them; it is true of anthropology and it is true of us.

Having said all this, as you read the research paper based on the experiment I conducted, keep in mind that it is my small tribute to the complexity and beauty of human life. Annie Dillard mentions in her book, *For the Time Being*, that "many people cannot tolerate living with paradox. Where the air is paradoxical, they avoid breathing and exit fast" (1999, p.197). For me, that is not the case. As a scientist, I hope to embrace paradox in order to open myself to the possibilities that research has to offer, which oftentimes involves results that are completely unexpected and contradictory. As for my feelings on agency and volition, what I take away from this project is that we are so exquisitely interwoven into the fabric of things that even our contribution to our own

life is smaller than a grain of sand. The thought, however, should not be discouraging; we may only be the witnesses to our life, but that does not prevent us from asking ourselves how we ought to live. In fact, perhaps asking ourselves the question informs the subconscious processes of our brain of the new direction in which we should seek meaning from the world around us. Moreover, the feelings of isolation and loneliness that may sometimes accompany being the solitary kings of a one person kingdom would vanish if we realized that we are part of something *big*. We do not have to be blind, deaf, and mute, sitting in our throne, in which we control…what? Instead, we can embrace the fact that we are constantly being formed by the world outside and the world within, that our body is incredible, beautiful, and full of drive to live, and that as small as we are in the grand scheme of things, we are all the witnesses to our own amazing miracle.

II. RESEARCH EXPERIMENT: *PRIMING AND THE BRAIN*

Abstract

Previous studies have found that priming participants for the goal to achieve leads them to perform better in a task, such as a word-search puzzle, than control participants. The current study investigated the effects of priming participants for the goal to achieve, the effects of priming participants for the goal to give up, and effects of priming for the goal to achieve and give up simultaneously. We measured differences in behavior and brain activity between these conditions. Our results indicate that, contrary to what we had predicted, priming participants for the goal to achieve leads them to find fewer words in a word-search task than control participants; this is true even when the giving-up prime is present simultaneously. On the other hand, priming participants to give up has no significant effect on the number of words found. Similar results were observed in terms of the amount of time the participants spent working on the puzzles. We also found that neither priming for achievement nor priming to give up has a significant main effect on brain activity, but a significant interaction was observed. We concluded that it is possible that the environmental conditions in which the participants were tested, which may have motivated them to protect their self-worth, priming participants for the goal to achieve has a reverse behavioral priming effect.

Priming and the Brain: A Case of Unexpected Reverse Priming

A vast body of research literature has shown that goals can be activated outside of awareness, without the need of conscious guidance to monitor the behavior and cognitive processes necessary to achieve the desired end-state (Bargh, Green, & Fitzsimons, 2008; also see Bargh & Gollwitzer, 1994; Bargh, Lee-Chain, Barnodollar, Gollwitzer, & Trötschel, 2001; Chartrand & Bargh, 1996; Oettingen, Grant, Smith, Skinner, & Gollwitzer, 2006). For example, the goal to perform well can be activated without explicitly telling participants that they need to perform well, and participants can pursue that goal without ever becoming consciously aware that they are doing so (Bargh et al., 2001). Furthermore, automatic goal pursuit consists of the same characteristics that describe conscious goal pursuit, such as vigorous acting toward goal attainment, persistence in the face of obstacles, and resumption after disruption (Bargh et al., 2001). The majority of the experimenters that have conducted this research have used priming to activate goal pursuit at a subconscious level. Priming is defined as the passive and unobtrusive activation of a mental representation (in this case a goal) by external stimuli, such that people are not and do not become aware of the influence exerted by those stimuli (Bargh et al., 2008). In accordance with this definition, priming manipulations have activated goals ranging from cooperation (Bargh et al., 2001), to socializing (Sheeran et al., 2005), to making money (Aarts, Gollwitzer, & Hassin, 2004), to achievement (Bargh et al., 2001), among others. However, the mechanisms by which priming works in the brain are not yet clearly understood. Consequently, many questions remain unanswered as to how the priming of goals gets translated into action by the brain.

A plausible theory is that goals are mentally represented in a person's mind as preexistent desired states (Aarts, Custers, & Holland, 2007). That is, the only goals that can be primed are those that the person has previous knowledge of and a previous desire to complete. Therefore, activating those goals through priming means activating mental representations or knowledge structures that have been followed before and can be followed again because the person has knowledge of the goal, the actions involved in attaining it, and the opportunities and situational features related to it (Aarts et al.). In addition to the mental representation of a goal, the priming of goals also depends on their mental accessibility, whether or not there is a discrepancy between the state the prime represents and the actual state, and, most importantly, on the goal's association with positive affect (Custers & Aarts, 2005). In fact, a study found that positive affect facilitates goal pursuit, whereas negative affect puts the pursuit of pre-existing goals on hold (Aarts, Custers, & Veltkamp, 2008). Similarly, when goal priming is paired in close temporal proximity with negative affect, the effects of the priming manipulation vanish (Aarts et al., 2007). Furthermore, when discrepancies are present, such that the represented goal or concept conflicts with the participants chronic goals, the effects of priming disappear (Glaser & Kihlstrom, 2005), and, in some cases, reverse priming occurs (Moskowitz, Gollwitzer, Wasel, & Schall, 1999), which means that the brain automatically compensates or corrects the unwanted prime so that the effect resembles that of priming for the opposite goal (an egalitarian goal instead of a stereotyping goal, for example).

Even more specific than the cognitive factors that can influence the effects of goal priming, there are also neurological factors that can affect when priming can activate goal pursuit. For example, when two or more goals are operating at the same time, whether they are conscious or non-conscious, they compete for the same cognitive resources and mental hardware, such that a person may be less capable of pursuing a goal if the mental hardware is already being used to pursue another goal (Aarts et al., 2008). More specifically, the generation and maintenance of goal representations as well as the maintenance of rules and planning of rule-based action involved in goal pursuit seems to take place in the prefrontal cortex (PFC), which helps us to guide our attention and behavior to goal-relevant cues (Berkman & Lieberman, 2009; Dijksterhuis & Aarts, 2010). Here, attention is simply defined as the selective processing of one aspect while ignoring other irrelevant aspects (Dijksterhuis & Aarts, 2010). Therefore, if the cognitive resources of the prefrontal cortex are already occupied in pursuing one goal, the probability that a person is capable of pursuing a different goal diminishes, especially if the goals are conflicting. Furthermore, the initial activation and maintenance of goals is also determined by unconscious neurological factors. For example, when we perceive cues that have elicited rewards in the past, dopamine is released in the PFC in order to secure the needed attention to pursue the goal associated with those positive cues (Dijksterhuis & Aarts, 2010). If the goal requires action, the anterior cingulate cortex also plays a role in triggering norepinephrine release in the locus coeruleus, enhancing focused attention processes in the PFC (Dijksterhuis & Aarts, 2010).

The aim of this study was to observe the behavioral effects of priming and to further investigate the mechanisms by which priming activates goal pursuit in the brain in order to better understand some of the criteria required for the activation of a concept to be translated into action. Specifically, this study analyzed whether priming activates goals by heightening the accessibility of those specific goals in the brain, resulting in a larger amplitude of mental activity in the PFC (Berkman & Lieberman, 2009). The two goals analyzed were achievement and giving-up; we expected to see a similar pattern of activity for both. Previous studies have used EEG recordings to measure brain activity during priming of semantic information (Sheppard II & Boyer, 1990). The current study used EEG data to measure cortical activity during the priming of goals. The study also further examined the mechanisms through which priming works in the brain by priming for the goal to achieve and the goal to give up simultaneously. When priming for two, opposing goals at the same time, we expected to see the same level of activity in the prefrontal cortex as when only one goal was primed. There is no known precedence for the unconscious activation of two goals simultaneously, but these expectations were based on the view that concurrent goals cannot use the same resources (Dijksterhuis & Aarts, 2010). Therefore, the mental activity should be about the same level as when only one goal is primed at a time because, according to this view, only one goal will receive attention, while the other is put on hold.

Furthermore, this study looked at the behavioral effects of priming by priming participants for the goal to give up, which had not been done before, or the goal to achieve. We also looked at the behavioral effects of priming for the two, opposing goals

simultaneously. Individually, we expected priming for achievement to lead participants to perform better on a task and spend more time working on it and priming for giving-up to lead them to perform worse on the same task and spend less time working on it. In priming for both goals simultaneously, we speculated that one goal would overcome the other, such that instead of having the opposing goals cancel each other's effect, we would observe behavioral effects similar to that of priming for the goal to achieve alone. This hypothesis was based on the fact that the motivation to pursue a goal is signaled by its association with positive affect (Aarts et al., 2008) and that a goal that is paired with negative affect is put on hold (Aarts et al., 2007); achievement is a concept that is norm-conforming in the university setting in which this study was conducted and was more likely to lead to positive affect, whereas giving-up is a norm-violating goal that was more likely to lead to negative affect (Oettingen et al., 2006).

Method

Experimental Design

This experiment was a 2 (giving-up prime: present or absent) x 2 (achievement prime: present or absent) between-subjects factorial design, resulting in 4 conditions: a neutral condition, an achievement condition, a giving-up condition, and a dual condition (participants were primed for achievement and giving-up simultaneously). There were three dependent measures: the number of words that participants could find in three post-test, thematic word-searches, the number of minutes the participants worked on those puzzles, and the pattern of alpha wave activity in the prefrontal cortex while the participants were completing the post-test, thematic word-searches.

Participants

Eighty participants, 61 females and 19 males**,** were recruited from the General Psychology Subject Pool and participated for course credit. Other students were recruited from the Regis University student population to participate on a volunteer basis. Each participant was randomly assigned to one of the four priming conditions: neutral, achievement, giving-up, or dual.

Materials and Measures

EEG System. A Biopac EEG System (BIOPAC Systems, Inc.) consisting of two scalp electrodes and one reference electrode was used to record overall electrical activity in the prefrontal cortex; a headband was used to secure the electrodes in place. To analyze the level cortical activity, we looked at the standard deviation of alpha waves, which gave us an estimate of the synchronization of activity (Pflanzer, Uyehara, & McMullen, 2006).

Priming word-searches. For each condition, participants were given two word-searches, each made up of a 10 x 10 letter matrix with 13 words embedded in it, appearing in a straight line either from left to right or right to left, reading up or down, or diagonally reading either up or down (Bargh et al., 2001; Engeser, 2009). The order in which the puzzles appeared was counterbalanced. The list of words that the participants needed to find was listed below each word-search.

The two priming puzzles that the participants had to complete were different according to their condition. One of the puzzles the participants in the neutral, achievement, and giving-up condition completed contained the following 13 neutral

words : *equator, essence, indicate, iris, mention, moment, nitrogen, people, print, quote, ratio, rotate,* and *sight* (see *Appendix A*). In addition, these participants completed a second word-search that contained six neutral words (*appear, design, direction, history, point, whistle*) and seven words related to their priming condition (neutral: *circle, committee, event, page, place, smell,* and *verse*; achievement: *achieve, attain, compete, master, strive, succeed,* and *win;* giving-up: *fail, lose, quit, resign, settle, stop,* and *surrender;* see *Appendixes B-E,* respectively). Participants in the dual condition completed the achievement word-search and the giving-up word-search, which we modified so that the neutral words from the achievement word-search did not appear twice. Instead, the giving-up word-search for the dual condition had the following six neutral words: *equator, iris, nitrogen, people, quote,* and *rotate* (see *Appendix F*).

Post-test, thematic word-searches. All participants completed three post-test, thematic word-searches as a dependent measure of how many words they could find and how long they took working on the puzzles. Like the priming word-searches, each thematic word-search was a 10 x 10 letter matrix. Unlike the priming word-searches, these word-searches did not include a list of the target words the participants needed to find. Instead, they each had ten words embedded in each puzzle related to a theme. Each theme was specified at the top of the word-search (i.e. Food: *peach, eggs, corn, cabbage, cake, milk, bread, potato, apricot,* and *rice;* Color: *red, orange, violet, blue, pink, turquoise, yellow, tan, purple,* and *green;* Animals: *roach, mosquito, salamander, skunk, butterfly, deer, beetle, antelope, elephant,* and *hamster*)

Procedure

All participants signed a consent form prior to the experiment. Each participant was tested individually at a table facing away from a computer that was running the EEG program. The experimenter was unaware of the participants' condition and the participants were blind to the purpose of the study.

EEG System. The experimenter placed three electrodes on each participant, one on the right side of the forehead, above the eye, one on the right temple, and one on the earlobe (ground). The electrodes were connected to the BioPac preamplifier, which was controlled by a laptop computer running BioPac Student Lab software. After the electrodes were secured with a headband, the participants were asked to close their eyes and relax for two minutes in order to calibrate the EEG system. After calibration, EEG data was collected continuously for the rest of the experiment.

Priming Task. After calibration of the EEG system, each participant completed two priming word-searches presented on one page. Participants had as much time as they needed to find all 26 words. They were allowed to work on the word-searches in whichever order they wanted and to move back and forth between the puzzles.

Post-Test Task. After the participants were done with the priming task, they had as much time as they needed to work on the three post-test, thematic word-searches that were on the reverse side of the page. The number of words in each puzzle was not specified; the participants were only told that they should tell the experimenter when they felt like they had found as many words as they could. As with the previous task, they were allowed to work on the puzzles in whatever order they wanted and to move back and forth between puzzles (procedure adapted from Bargh et al., 2001). The time that

they took to work on the puzzles was recorded. After completing the post-test, thematic word-search task, the participants were questioned about any relation that they saw between the experimental task and the dependent measure using funnel debriefing (Ferguson & Bargh, 2004; see *Appendix B* for a list of some of the questions used, which varied from participant to participant). Finally, they were fully debriefed and thanked for their participation.

Results

For each dependent variable, any data point that was more than two standard deviations away from the group mean was excluded from analysis. We removed two scores from the number of words found in the post-test, thematic word-searches, three from the time spent working on the post-test, thematic word-searches, and three from the alpha activity during the post-test, thematic word-searches.

The means and standard deviations of all dependent variables are presented in Figures 1-3. For the number of words found in the post-test, thematic word-searches, there was a significant main effect of achievement, such that participants exposed to words related to achievement found fewer words than participants not exposed to achievement words ($F(1, 74) = 10.46$, $p = .002$). On the other hand, there was no significant main effect of giving-up priming ($F(1, 74) = 2.72$, $p = .10$). The interaction between the number of words found following the achievement prime and following the giving-up prime was not significant ($F(1, 74) = .99$, $p = .32$).

The achievement prime also had a main effect on the amount of time spent working on the post-test, thematic word-searches, such that participants exposed to words

related to achievement worked on the word-searches for a shorter period of time ($F(1, 73) = 7.53$, $p = .008$). Again, the giving-up prime did not have a significant main effect ($F(1, 73) = .24$, $p = .62$). The interaction between achievement of time spent working on the word-searches between the achievement prime and the giving-up prime was not significant ($F(1, 73) = .09$, $p = .77$).

There was only a marginally significant effect of the giving-up priming on the alpha wave activity during the post-test, thematic word-searches, indicating that priming participants to give up may lower the level of electrical activity in the PFC ($F(1, 73) = 3.41$, $p = .07$), but no effect of achievement priming on alpha waves ($F(1, 73) = .08$, $p = .78$). The interaction between the achievement priming and giving-up priming on the alpha wave standard deviation during the post-test, thematic word-searches, on the other hand, was significant ($F(1, 73) = 12.00$, $p = .001$). Post-hoc pairwise comparisons revealed that in the absence of the giving-up prime, the achievement prime increased the level of alpha wave activity in the PFC compared to the control group ($t(73) = 2.68$, $p = .01$, $d = 1.24$), but in the absence of the achievement prime, the giving-up prime did not have the any effect on the level of activity ($t(73) = 1.46$, $p = .31$, $d = 0.34$). Interestingly, when both primes were presented simultaneously, the level of alpha wave activity returned to baseline, showing no significant difference from the control group, such that the effect of the achievement prime was no longer observed ($t(36) = 1.65$, $p = .11$).

Discussion

Behavioral Findings

The results of this study suggest that priming participants for the goal to achieve leads them to perform poorly in a word-search task compared to control participants. This effect is true regardless of whether or not participants are simultaneously primed with the goal to give up. On the other hand, priming participants for the goal to give up did not have an effect on the number of words that participants found or the amount of time they worked on the word-searches.

This experiment was the first one to test the behavioral effects of priming for the goal to give up. Thus, there is no previous research to elucidate why the giving-up prime had no significant effect on behavior. Previous research shows that when a prime is paired in close proximity with words related to negative affect, the effects of the priming manipulation vanish (Aarts et al., 2007). However, the participants in this study were not exposed to words directly related to negative affect, and the link that the goal to give up has with negative affect cannot be established with certainty. For example, during debriefing, the participants in the giving-up condition who noticed negative words in the priming word-searches expressed that they felt very good after they were able to get through "those negative words." It is possible that completing a word-search with negative words in it allows participants to regain the sense of self-efficacy that they may have lost while being primed for the goal to give up. In other words, the goal to give up may have been challenged and cancelled by the goal to finish the word-searches, which participants were instructed to do.

In terms of the effects of the achievement prime, the results we obtained in this study were completely opposite of what we expected. A study conducted by Bargh and

colleagues in 2001 showed that priming participants for the goal to achieve led them to find more words in subsequent word-search puzzles than control participants. A more recent study found the same results in a meta-analysis of three experiments using procedures similar to those used in the study done by Bargh (Engeser, 2009). Based on these studies, we expected that priming participants for the goal to achieve would lead them to find more words and spend more time working on the word-searches, but instead we found the opposite.

One possible explanation for our results is that the population sample used for this study may have been a group of chronically low-achieving students. Research shows that achievement priming activates a goal to have fun and inhibits a goal to achieve in individuals with chronically low-achievement motivation (Hart & Abarracin, 2009). Thus, participants primed to achieve could have been operating on the goal to have fun and not taken the experimental word-search puzzles seriously, taking less time to work on them and finding fewer words. However, because the sample was random and chosen from a population of college students, it is unlikely that all the participants who took part in the study were chronically low-achieving students. Furthermore, the study that tested this hypothesis found that when chronically low-achieving students are primed for achievement, thus activating in them the goal to have fun but inhibiting the goal to achieve, their performance returns to baseline (Hart & Abarracin, 2009); in that study, there was no reverse priming effect, meaning that the participants' performance did not mirror that of priming for the opposite goal (Moskowitz et al., 1999). Thus, our results

are still somewhat incompatible with this explanation because, in our case, a reverse priming effect was observed.

Another possible explanation for our results is that participants primed to achieve tend to form high expectation outcomes on task performance compared to control participants, which means that, before they complete a task, participants primed for achievement predict that they are going to be successful at a task (Custers, Aarts, Oikawa, & Elliot, 2009). Thus, it is possible that participants exposed to the achievement prime became satisfied with their performance on the dependent measure task sooner than control participants and found fewer words because they had anticipated that, no matter what, they were going to perform well. In fact, participants primed to achieve are more likely to experience self-agency over a task outcome only when the outcomes are high, but not when the outcomes are low (Custers et al., 2009). For example, if the participants receive a high score on a task, they claim agency over the task even if they had no control. On the other hand, if they receive a low score, they claim that they had no control over the task (Custers et al.). Therefore, participants who are primed for achievement retain a high expectation outcome throughout the task, regardless of actual performance. This explanation, however, contradicts the findings of previous studies, which, as already mentioned, have found that priming participants for achievement leads them to perform better on a dependent measure task than control participants.

The best explanation for our results is based on the fact that participants who are motivated to protect self-worth perform poorly in situations that threaten to reveal low ability while performing well in situations that do not threaten to reveal low ability

(Thompson & Perry, 2005). Perhaps, participants primed for achievement were more likely than participants primed to give up to protect their self worth because they felt a greater expectation to perform well. In addition, an outstanding difference between the study conducted by Bargh and colleagues and this study is that participants in this study were connected to an EEG, and their brain activity was being recorded. The knowledge that their brain activity was being recorded could have made participants who were primed to achieve feel more threatened by the possibility of the EEG scan revealing their low ability than participants in the control group or giving-up group. Future studies are needed to explore this possibility further, however, given the behavioral and EEG findings of this experiment, this is the most likely explanation.

Future studies on behavioral effects. Future studies should asses the theory that the EEG led participants to have high self-worth protection, causing them to perform poorly compared to controls. In order to do so, they should consider replicating this design with an additional group that controls for the EEG. Such control group could involve not having anything attached to their foreheads at all, or they could have electrodes attached to their foreheads, but not have the electrodes connected to an EEG system. Regardless, it is important to investigate the effects that the EEG system had on behavior. Furthermore, the theory that high expectation outcomes influence the participants' behavior after priming should be assessed by future studies by not telling the participants ahead of time that they were going to complete three thematic word-searches after having completed the first two, priming word-searches. In this way, the probability that they develop high expectation outcomes after they are primed for achievement

diminishes. Finally, future studies should asses the theory that the participants used in this study were low-achieving students by replicating this study with a different population sample.

EEG Findings

There was no significant effect of either the achievement prime or the giving-up prime. Yet, there was a significant interaction between the two. In the absence of the giving-up prime, priming for the goal to achieve seemed to increase the level of activity in the PFC. On the other hand, in the absence of the achievement prime, the giving-up prime seemed to have no effect on the level of alpha wave activity. Interestingly, when both primes were presented simultaneously, the effects of the achievement prime seemed to disappear, and the level of alpha wave activity returned to baseline.

We speculate several reasons accounting for this interaction. Based on the behavioral results, we know that priming participants to achieve led them to have a poor performance. One of the plausible explanations discussed was the possibility that participants who were in the achievement condition developed a motivation to protect their self-worth because they were under greater pressure to perform well, and thus felt more threatened by the possibility that the EEG would reveal their low ability. There is supportive evidence for this possibility in light of our EEG findings from fMRI research that has shown that internal appraisals about current states (Berkman & Lieberman, 2009; Lieberman, Jarcho, & Satpute, 2004; Northoff & Bermpohl, 2004; Ochsner et al., 2005) and evaluations about self-referential stimuli (Gusnard, Akbudak, Shulman, & Raichle, 2001) are processed in the medial prefrontal cortex and dorsomedial prefrontal cortex,

which means that if participants exposed to achievement words were processing internal appraisals such as “how am I doing?” or analyzing self-referential stimuli (e.g. do I posses this trait?) they would show an increased level of activity in those areas. This explanation would account for why there was an increase in mental activity, but a decrease in performance.

This explanation would also account for why we did not observe significant changes in brain activity for the participants in the giving-up condition; those participants were not evaluating their progress or their self-worth because they were under no pressure to perform well, which is also consistent with the behavioral results in which they demonstrated to perform at baseline. Similarly, the baseline-like alpha wave activity of participants in the dual condition could be accounted by the possibility that the presence of the giving-up prime attenuated the pressure felt by the participants to perform well, leading to a lowered threat to reveal their low ability and lower brain activity as compared with the achievement group.

It is important to remember, however, that increased activity could mean increased activation of some process, but it could also mean increased inhibition of that process (Sheppard II & Boyer, 1990). Thus, as suggested by previous studies, if priming for achievement inhibits the goal to achieve in chronically low-achieving students, then the increased brain activity could be due to increased inhibition of this goal (Hart & Abarracin, 2009). This would explain why the interaction is present; if priming for achievement means increased inhibition of behavior (reflected in higher brain activity), and priming for giving-up means a release from any goal to perform well, then combing

the two would result in similar activity to that of the control group because the effect of the achievement prime was cancelled.

Future studies on brain activity effects. Future studies are crucial in order to define more specifically what the activity observed really means, and where, precisely, it is located. Our study used only two electrodes to record electrical activity in the prefrontal cortex. However, the fMRI studies reviewed here are much more precise than that. Thus, being able to record exactly where the activity is would help us elucidate what the activity means. Future research should attempt to replicate this study using EEG equipment that is more sophisticated or even using an fMRI. This would allow for more detail on the level of activity, the kind of activity, and the precise location of the activity in the brain. Such studies could focus on looking at activity specifically in the medial prefrontal cortex or the lateral prefrontal cortex. A more standardized method of placing the electrodes on the forehead would also be beneficial to improve the precision of where the in the prefrontal we are recording the activity.

Conclusion

Priming does not always affect behavior as anticipated. Even though previous studies have suggested that priming leads to measurable and predictable outcomes of behavior related to the goal being primed, here we show that this is not always the case. Priming can lead to the opposite effects under certain, specific environmental or psychological circumstances, which may affect the self-efficacy or self-worth of individuals, influencing their performance in unexpected ways. Furthermore, we

conclude that the relationship between electrical activity in the prefrontal cortex and behavior remains unclear.

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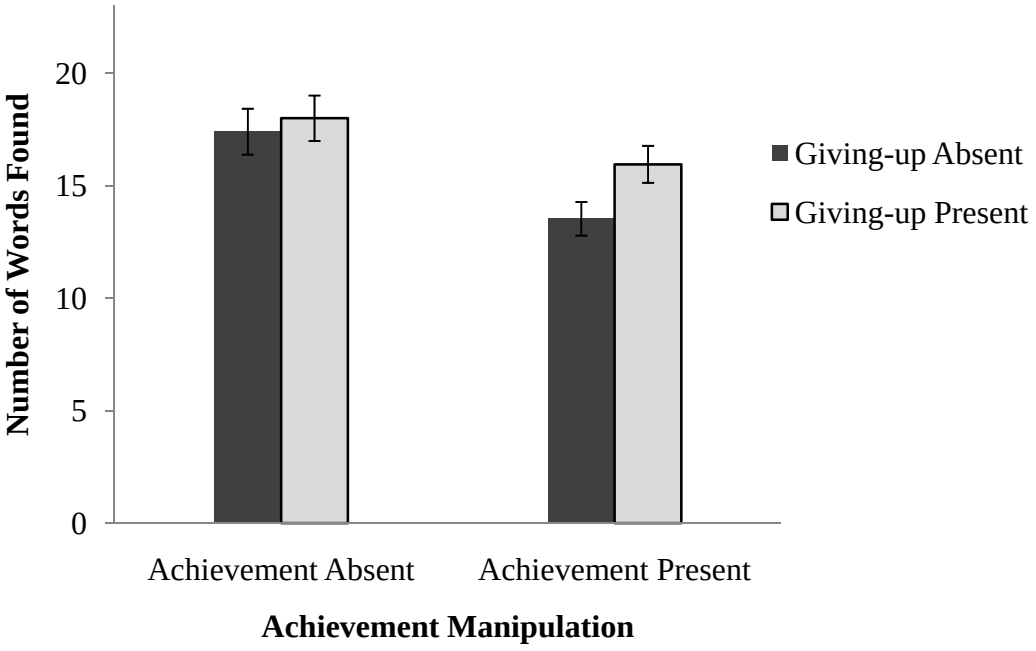


Figure 1. Mean number of words participants found in each condition. The error bars represent standard error.

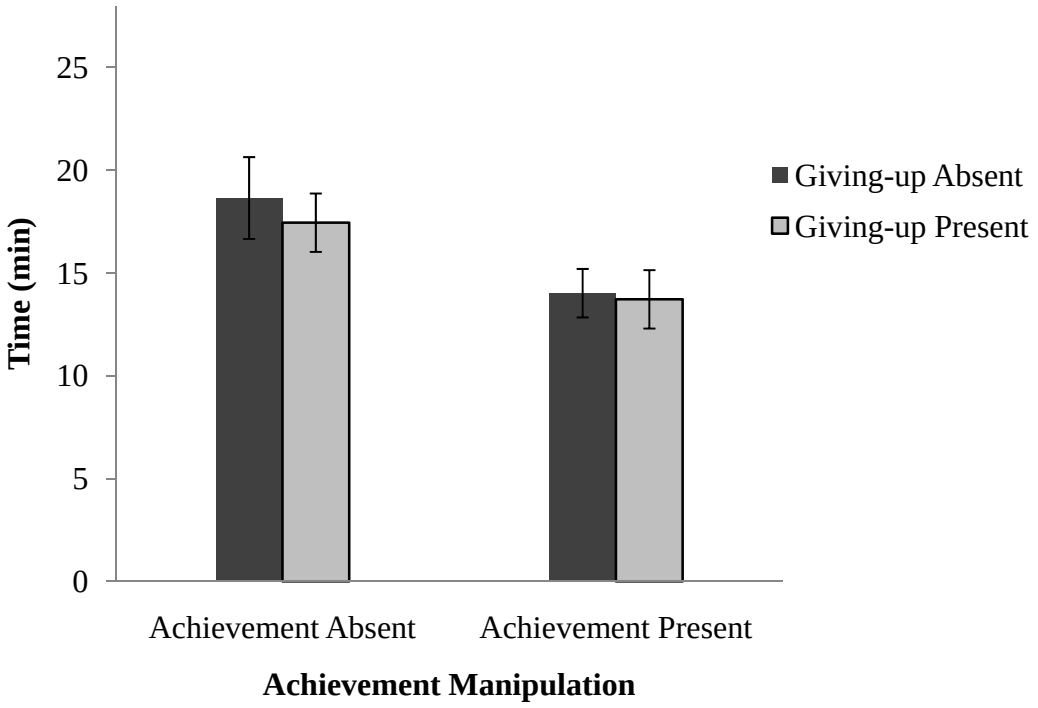


Figure 2. Mean time, in minutes, that participants from each condition took to work on the three post-test, thematic word-searches. The error bars represent standard error.

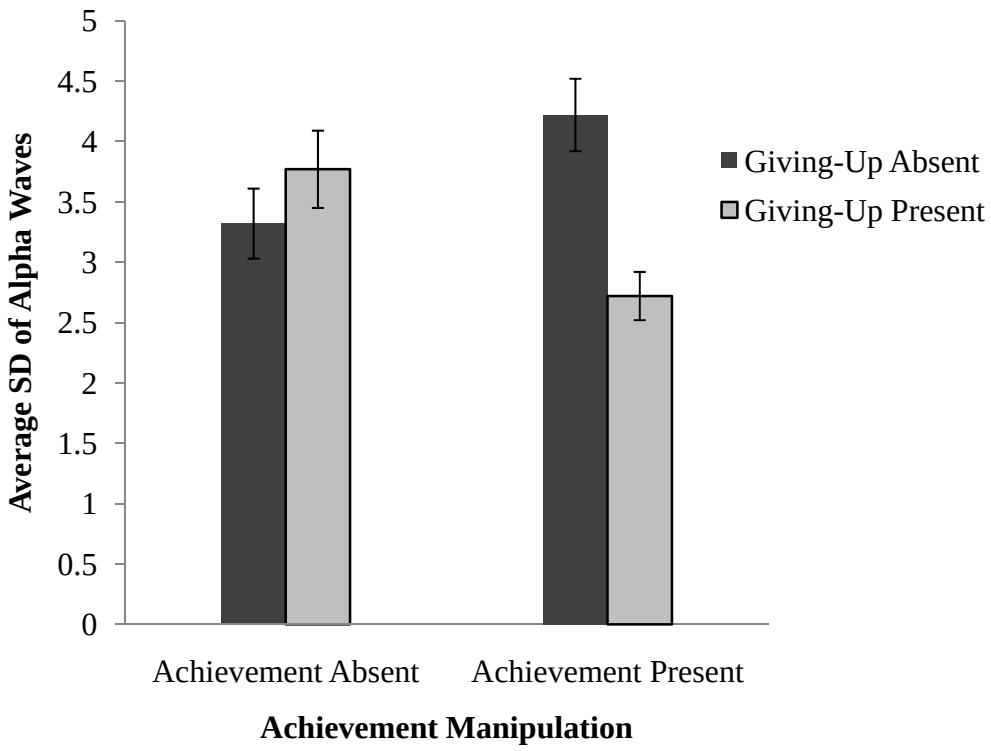


Figure 3. The average standard deviation of alpha activity during the post-test, thematic word-searches. The error bars represent standard error.

Appendix A

Priming Word Searches

E L D E H V Q E R E
J L G E E B L Z C V
L A T R S C X O Y E
P L S S R I M Z R N
M E E I I M G J O T
E H C M I H M N T N
V V M T S R W E S I
B J T E C A L P I O
Q E A P P E A R H P
E N O I T C E R I D

APPEAR
CIRCLE
COMMITTEE
DESIGN
DIRECTION
EVENT
HISTORY
PAGE
PLACE
POINT
SMELL
VERSE
WHISTLE

Figure A1. Neutral word search completed by all participants except those in the dual condition.

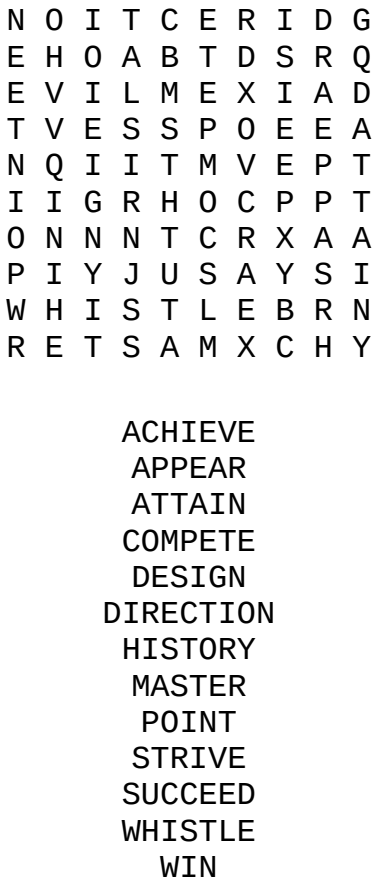


Figure A2. Achievement prime word search completed by participants in the achievement condition and the dual condition.

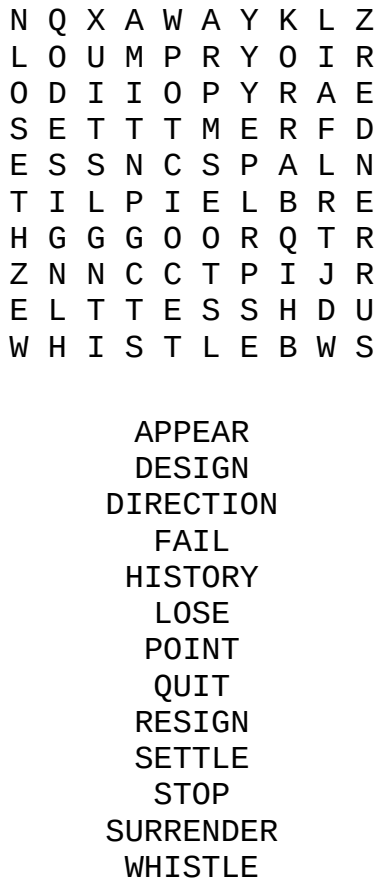


Figure A3. Giving-up priming word search completed by participants in the giving-up condition.

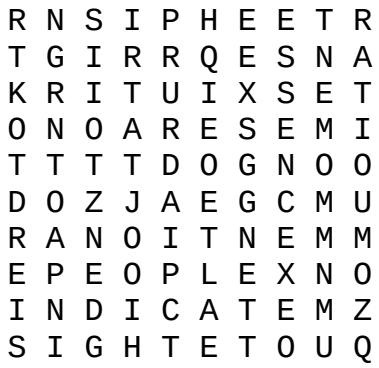
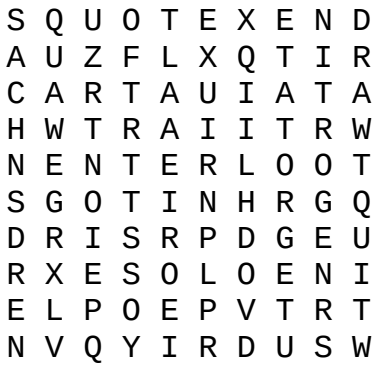


Figure A4. Neutral word search completed by participants in the neutral condition.



EQUATOR
FAIL
IRIS
LOSE
NITROGEN
PEOPLE
QUIT
QUOTE
RESIGN
ROTATE
SETTLE
STOP
SURRENDER

Figure A5. Giving-up word search completed by participants in the dual condition.

Appendix B

Funnel Debriefing Questions

- Do you have any suspicion as to what the exact purpose of the experiment was?
- What do you think was the purpose of the first two word-searches?
- Do you think that the amount of words you found in the three thematic word searches would have been different had you not done the first two word searches?
- Do you think that the first two word-searches affected how many words you found in the subsequent thematic word-searches?
- Did you notice any change of mood or behavior after completing the first two word searches?
- Were you aware that this experiment was using a priming procedure?
- Were you aware that the first two word searches were priming you for a goal?