Yes It Can: On the Functional Abilities of the Human Unconscious

Ran R. Hassin

Word count:

Abstract: 184

Main text: 7397

Ran R. Hassin

Department of Psychology and

The Center for the Study of Rationality

The Hebrew University, Israel

Email: ran.hassin@huji.ac.il

Abstract

Understanding the division of labor between conscious processes and unconscious ones is central to our understanding of the human mind. This paper proposes a simple Yes It Can (or YIC) principle: It argues that unconscious processes can perform the same fundamental, high-level functions that conscious processes can perform. I present considerations of evolutionary pressures and of the availability of mental resources that render YIC a reasonable hypothesis. I then review evidence from various sub-fields of the cognitive sciences, which shows that functions that were traditionally thought of as requiring consciousness can occur non-consciously. Based on these data and arguments it is proposed that an answer to the question *What Is It That Consciousness Does* would not be in the form of *Consciousness is necessary for F*, where F is a fundamental, high level cognitive function. In Marr's (1982) terms, the argument is that *computationally* conscious and unconscious processes are very similar. Yet, differences in how these processes kick in, and in the ways in which they play out (Marr's the *algorithmic-representational* level), are likely to have interesting implications for human cognition, motivation and emotion.

> Our hypothesis thus leads us to the radical suggestion that the critical difference between the thinking of humans and of lower animals lies not in the existence of consciousness but in the capacity for complex processes outside it". Neisser, 1963, p. 10

Which high level cognitive functions can the unconscious perform, and which are uniquely conscious? This question is central to many areas of investigation in the cognitive sciences, ranging from philosophy to cognitive neuroscience, with far reaching implications to neighboring fields. In this paper I propose a very simple principle: Unconscious processes can carry out every fundamental high-level function that conscious processes can perform. For brevity, I will refer to it as the Yes It Can, or YIC, principle. An important implication of this principle is that a scientific answer to the question *What Is It That Consciousness Does (That the Unconscious Cannot Do)* would not be in the form of *Consciousness is necessary for F*, where F is a fundamental cognitive function. Put differently, if consciousness is evolutionarily advantageous it is not in the way of enabling a survival-enhancing cognitive function(s) that cannot be achieved non-consciously[1]. As I argue later, this view does not mean that consciousness does not affect our lives, or that it is not advantageous.

There are two good a priori reasons to suspect that YIC holds. First, one of the most consistent and replicable finding in the cognitive sciences teaches us that our consciousness is very limited in its processing capacity (Baddeley, 2007; Kahneman, 1973). Given the sheer volume of high-level cognitive processes that we conduct on a daily, hourly, and minutely basis (think, for example, on the number of goals we pursue at any given point in time: from being good spouses, through planning parties for our children, to cracking a mystery we encountered at work), waiting in queue for a very limited conscious system seems very inefficient. Hence, it seems reasonable to suspect that these functions can also be carried out non-consciously.

Second, our best theories to date suggest that the brain was evolutionarily designed over eons, and that conscious awareness as we experience it today is a relatively recent development (e.g., Dennett, 1995; Reber, 1992; Rozin, 1976). Given what we know about how evolution works, it seems unlikely, then, that much of our brain (and brain-power) is dedicated to consciousness or to processes that

---

[1] I use the terms *unconscious* and *consciousness* for ease of discussion; I do not mean to suggest that these are mental entities, or systems (Keren & Schul, 2009). More on this issue in the *On Consciousness* section below.

necessarily require consciousness. Hence, fundamental cognitive functions are likely to occur outside of conscious awareness.

But arguments that render a hypothesis plausible are not enough in the sciences: One needs to provide supporting empirical data. My approach in the rest of this paper is to illustrate YIC in fundamental, high-level functions that were traditionally associated with conscious awareness. To this end, I will review recent and exciting developments in cognitive and social psychology, as well as in the cognitive neurosciences. The reviewed data show that functions that were traditionally assumed to require consciousness can occur non-consciously. Based on the arguments presented above, and the empirical data reviewed below, I propose the YIC principle: Namely, that unconscious processes can carry out every fundamental high-level function that conscious processes can perform.

Data provide demonstrations, they are not proofs. Because of this inherent limitation, and interpretational ambiguities, data are bound to leave question marks. Hence, one could always come up with a function, $F_{current}$, which was not previously examined, and suggest that $F_{current}$ (rather than all previously suggested Fs) *requires* consciousness. I will argue, however, that if one adopts the method of inquiry suggested herein, the accumulated data make it reasonable to suspect that $F_{current}$, too, can occur without awareness.

The fact that the unconscious processes can perform a function F does not entail that they will always perform it. In a later section I suggest three factors that determine whether a function F will or will not be carried out non-consciously at a given point in time. I end the paper by discussing the implications of this view to our understanding of consciousness. I argue that functional similarity does not necessarily imply that there are no differences between conscious and unconscious processes. In other words, YIC does not imply that consciousness does not play a role in our lives. Rather, it sends us to look for the differences elsewhere: not in the functions themselves, but in how they kick in and play out.

Before turning to the evidence and arguments, however, there are three conceptual issues that need to be succinctly addressed.

Three Introductory Notes

Three Definitions

The terms *cognition* and *cognitive processes* are used here in a very wide sense. In the language of the (probably erroneous) computer metaphor, I use 'cognition' to denote the software of the brain,

regardless of whether this software does what scientists of the mind call cognition, motivation or emotion.

The term *high-level cognition* covers post-perceptual cognitive processes that require what people usually think of as complex computations and cognitive control. Examples can probably do here better than definitions (Wittgenstein, 1963), so here is a partial list: causal reasoning, decision making, conflict management, metaphor comprehension, understanding- and reasoning by analogies, problem solving, self control, inferences of various kinds, executive functions, working memory, abstract thinking, planning.

Lastly, cognitive functions vary in their fundamentality, that is – in how inherent they are to normal cognitive functioning – and in their level of abstractness (Rosch, Mervisa, Gray, Johnson, & Boyes-Braem, 1976). The argument made here concerns fundamental, basic-level functions. Given that we lack taxonomies of cognitive functions, this definition is inherently ambiguous. I suspect, however, that there is relatively wide consensus about these issues [e.g., which one of the following hypothetical functions is fundamental and basic, and which is not: (a) the function of information broadcasting – i.e., making information available to many different parts of the brain; (b) the function of transforming the perception of the word "Stop!" into a pre-defined series of key presses on the keyboard]. I will use the term *fundamental function* as a shorthand for *fundamental, basic level function*.

Two types of literatures: Subliminal Perception vs. Unconscious Cognition

An important distinction in the context of the current paper is that between *subliminal perception* and *unconscious cognition* (see Bargh & Morsella, 2008). Subliminal priming s a subset of unconscious cognition, in which the stimuli are not consciously perceived. Yet, the literature on subliminal priming and that on unconscious cognition have developed rather independently. Scientists of subliminal priming investigate the extent to which non-consciously perceived stimuli can be processed, and the effects that they have on other processes (for recent reviews see Kouider & Dehaene, 2007; Van den Bussche, Van den Noortgate, & Reynvoet, 2009). Scientists of unconscious cognition examine unconscious processes without limiting themselves to subliminality. What is critical for them is that one is not aware of the relevant process and/or their products (for recent overviews see J. A. Bargh, 2007; Gawronski & Payne, 2010; Hassin, Uleman, & Bargh, 2005).

Each of these approaches suffers from its unique shortcomings, and hence a comprehensive understanding of the unconscious must rely on both. The main disadvantage of the literature on

unconscious cognition is that it often relies on subjects' subjective reports regarding their internal states, reports that are known to suffer from two major limitations. First, they cannot be observed from the outside. Second, psychological science has repeatedly demonstrated that our introspective capacity – so crucial for many subjective reports – is very limited (for an elaborate discussion see Wilson, 2002).[2]

The main disadvantage of the subliminal priming literature is that it focuses on a limited subset of unconscious cognition, where the stimuli are presented for a very brief period, in the order of tens of milliseconds, and are then immediately masked. Naturally, this procedure yields weak signals. Thus, failures to demonstrate a cognitive function *F* in subliminal priming experiments may be either attributed to limitations of the unconscious, or to the weakness of the signal. Such failures, then, leave open the possibility that F can occur non-consciously when the signal is strong enough (Bargh & Morsella, 2008).

One Functional Stance

I suggest that we adopt a functional stance, that is – that we discuss questions such as the one raised in this paper in terms of cognitive *functions*. One identifies a cognitive function of a process P when one gives a teleological answer to the question *What is it that P does*. Here are a few examples. One function of working memory (the one we usually call short term memory) is to maintain a short list of objects for a short period of time. The function of inhibition is to make a mental object less available/accessible. The function of causal inference is to establish causal relationships between events[3].

Marr (1982) famously distinguished between three levels of analysis: the computational level – what does the system do and what does it do it for; the algorithmic/representational level – how does the system go about doing what it does, and the implementational level – how is the system implemented in the physical world. In Marr's (1982) terminology, then, I suggest that we stand much to gain from focusing on the computational level.

One advantage of the functional stance is that it allows us to refrain from confounding a functional characterization of a process with a description of its characteristics (which was one of Marr's basic points). It keeps us alert to the fact that the *how* question – how are functions achieved – is largely independent from the *what (or what for; the computational level*) question. Applied to the current

---

[2] It is interesting to note that in recent years there is a resurgence of interest in self reports as measures of awareness (Dienes & Seth, 2010; Overgaard, Timmermans, Sandberg, & Cleeremans, 2010).

[3] These definitions *are meant as demonstrations* of the stance*;* they are not meant to be exhaustive.

concerns, this stance suggests that if one is interested in a certain cognitive function, one may gain from not defining it via the property of being conscious (e.g., conscious self control) – unless one wants to restrict herself to a subset of all possible cases.

With all this in mind, we can now turn to the data. In the following sections I discuss four families of fundamental cognitive functions: cognitive control, goal pursuit, information broadcasting and reasoning. These functions were chosen to illustrate YIC because they are fundamental and high-level, they were traditionally assumed to require consciousness, yet relatively recent developments in the cognitive sciences suggest that we may benefit from re-examining the assumption that they are necessarily conscious.[4]

Function 1: Cognitive control

Traditionally, cognitive control and working memory (WM) were closely associated with conscious awareness (e.g., Baars & Franklin, 2003; Baddeley, 2000; Kintsch, Healy, Hegarety, Pennington, & Salthouse, 1999; for a more elaborate discussion see Hassin, 2005; Hassin et al., 2009). Cognitive control is an umbrella term that covers many executive functions and general purpose procedures that allow the cognitive system to better achieve its goals. These include, but are not limited to, inhibition, shifting and updating (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000), resource allocation (Kahneman, 1973; Norman & Shallice, 1986), as well as task setting (Meiran, 2010).

 Recently it has been shown that various control mechanisms, as well as WM, can operate non-consciously. In a pioneering study conducted by Lau and Passingham (2007) participants switched between two simple tasks, where the explicit instruction of which task to perform on the nth trial appeared only at the beginning of that trial. Crucially, a subliminal cue that appeared before this explicit instruction provided information about the task on trial n, information that could either be congruent or incongruent with the explicit instructions. Behavioral results showed that the subliminal primes put cognitive task-setting control processes in motion: When the subliminal primes were incongruent with the explicit instructions, participants were less accurate and slower than when they were congruent.

---

[4] As a result of adopting these criteria, this paper does injustice to many earlier and groundbreaking findings about the functional capacities of the unconscious (for overviews see, e.g., J. A. Bargh, 2007; De Gelder, de Haan, & Heywood, 2001; Hassin, Uleman, et al., 2005; Morewedge & Kahneman, 2010; Nisbett & Wilson, 1977; Reber, 1993; Reder, 1996; Underwood, 1996; Wegner & Vallacher, 1977; Wilson, 2002).

fMRI data corroborated these findings by showing effects of the subliminal primes on activity in relevant cognitive control areas.

More recent studies examined the effects of subliminal cues on related forms of control. They documented subliminal activation of conflict adaptation and inhibitory control on classic tasks such as the go/no-go and the stop signal (Van Gaal, Ridderinkhof, Johannes, Scholte, & Lamme, 2008; van Gaal, Ridderinkhof, Scholte, & Lamme, 2010). Interestingly, some of these studies (e.g., van Gaal, Lamme, Fahrenfort, & Ridderinkhof, 2010) compared the effects of subliminal and supraliminal cues on cognitive control, and found that while control can follow both, it more frequently follows supraliminal cues. Similarly, ERP data showed that both conscious and unconscious control resulted in N2 and P3, but their shapes and sizes were not identical.

In related sets of studies it has been recently shown that subliminal reward cues can affect motivation, and hence effort allocation and investment, two classic functions of cognitive control (Bijleveld, Custers, & Aarts, 2010; Pessiglione et al., 2007).

Recently we have shown that WM – considered by many as the seat of conscious, control processing (Baddeley, 2007) – can operate outside of conscious awareness (Hassin, 2005; Hassin, Bargh, Engell, & McCulluch, 2009). This work complements previous lines of research that had established that two sub-components of working memory – verbal and visual short term memories – can operate outside of conscious awareness (e.g., Maljkovic & Nakayama, 1994; McKone, 1995). To examine implicit working memory we developed a paradigm in which small disks that are either empty (bagel shaped) or full appear in various locations on a computer screen, one at a time. Participants' task is to respond with one key-press if a disk is empty and with another if it is full. The disks appear in sequences of five, separated by a fixation square. In Pattern sequences, the locations of the disks create a pattern (e.g., a ZigZag). In the Broken Pattern condition, the locations of first four disks are identical to those of pattern sequences, but the fifth disks break the patterns. Pattern and Broken Pattern sequences are equally probable. Hence, the likelihood of a "pattern move" from the 4th to the 5th disk is identical to the likelihood of a "broken pattern" move. Hence, "simple" implicit learning across sequences cannot help performance in this task. Extracting the patterns and gaining from them requires active maintenance of ordered information (the locations of disks); context-relevant updating of information (with incoming disks) and goal-relevant computations (i.e., pattern extraction and anticipation formation). The extracted information is immediately available to control behavior and cognition, in the service of current goals (of being fast and accurate). These functions are traditionally associated with WM (Hassin,

2005), yet across a set of five experiments, that used various probing techniques, we failed to show any evidence of awareness.

Function 2: Pursuing goals and managing goal conflicts

Traditionally goal pursuit – the ways in which people attempt to get from their current state to the one they desire – was assumed to be a consciously controlled process (Ajzen, 1991; Bandura, 1986; Deci & Ryan, 1985; Locke & Latham, 1990). In the recent decade, however, it has been repeatedly demonstrated that goals can be activated non-consciously, and that they then go on to be pursued outside of conscious awareness (Bargh, 1990; Kruglanski, 1996). In a typical experiment, participants are led to believe that they take part in a series of unrelated tasks. Unbeknownst to them, the first task activates a goal (goal priming), and goal pursuit is measured in the second task. In a pioneering study John Bargh and his colleagues (2001) primed participants by having them do a word-search task that either contained a high proportion of cooperation related words (priming condition) or not. Participants then went on to take part in an "unrelated experiment 2" that consisted of a common resource dilemma – a situation in which one's interests are in conflict with those of a larger group. Participants primed with the goal of cooperation cooperated with the group more than those who were not primed. Yet, they did not consciously realize that a goal had been primed, or that they were more committed to cooperation.

Using methods of this sort, psychologists have primed goals such as solving puzzles, achievement, obtaining sex, and impression formation. In some of these studies, the goals are primed subliminally. In others, evidence for unawareness comes from debriefings in which participants' phenomenology is carefully examined. In a vast majority of these studies participants do not feel differently about the primed goal. In other words, while goal/motivation priming is strong enough to affect behavior, it does not seem to affect reported phenomenology (for recent reviews see Custers & Aarts, 2010; Dijksterhuis & Aarts, 2010; Fishbach & Ferguson, 2007).

Is goal priming an instance of habit priming, in the sense that the prime activates a well-rehearsed chain of behaviors? The answer seems to be negative. Take, for example, the experiment of Aarts and colleagues (Aarts, Gollwitzer, & Hassin, 2004), in which heterosexual male who were primed with the goal of seeking causal intimacy gave more feedback to a female (but not to a male) experimenter (this effect was not found in the control group). This experiment is a good illustration of a more general issue: Translating a primed goals into a concrete set of behaviors is a complex problem-solving-like process,

that is likely to include an assessment of possible behaviors (shall I run home? rush to a pub?), weighing in salient norms (unfortunately, social norms dictate that I stay in the booth), figuring out availabilities (shall I loudly sing Don Giovanni? provide help?), and exerting an effort in what seems to be the best route (by providing more feedback), but only if the primed construct is a applicable (the experimenter is a female).

Recently Tali Kleiman and I extended the literature on non-conscious goal pursuit by demonstrating that two goals can be in active conflict outside of conscious awareness (Kleiman & Hassin, 2011). We used the priming procedure and the common resource dilemma described above, taking advantage of the fact that dilemmas of this sort put us in a conflict between the dominant goal of being selfish and the non-dominant goal of being cooperative (Brewer & Kramer, 1986; Fehr & Fischbacher, 2003). Since cooperation is the non-dominant goal, priming it should result in increased conflict. And indeed, across six experiments, priming led to an increase in indirect markers of goal conflict (such as variability in repeated decisions, and increase in RTs and arousal). Yet, explicit measures did not yield any evidence for changes in felt conflict. In one of these experiments we assessed explicit conflict on each and every trial, replicating the general pattern: consistent effects on conflict measures, yet no detectable changes in phenomenology. A meta analysis of all relevant experiments, with 233 participants, still did not provide any evidence for changes in phenomenology.

Function 3: Information broadcasting

An influential view of the function of consciousness maintains that it allows for wide broadcasting of information in the brain, whereas non-conscious processes are more limited in audience and duration. Historically, this theory belongs to the subliminal priming literature, contrasting the effects of subliminally and supraliminally-presented information (Baars, 1997; Dehaene & Naccache, 2001). Yet, evidence accrued in recent decades suggests that information that is subliminally primed gets significant access to other processes in the brain. The previous sections detail findings of this sort, and here I add a short (and partial) list of findings from the subliminal priming literature that are of specific relevance to the current issue. Note, that the term *broad broadcasting*, while intuitively appealing, is not well defined, and hence one should expect some ambiguity in its interpretation.

Semantic priming

Although debated for well over two decades (for a relatively early discussion see. e.g., Greenwald, 1992), it seems that subliminal priming of a meaningful symbolic unit (e.g., a word, a number) allows

access to its semantics (Kouider & Dehaene, 2007; Van den Bussche et al., 2009). In other words, abstract, formal visual symbols communicate their meanings even when presented subliminally.

Cognitive Control

The experiment of Lau & Passingham (2007) that was succinctly described above showed that subliminal stimuli get access to control processes of the brain. As was described earlier, these early results were extended by various laboratories examining a wide range of cognitive control functions. Taken together, these findings suggest that subliminal information can drive executive functions.

Affect

Zajonc and colleagues have repeatedly shown that subliminal priming of stimuli changes how we feel about them when we actually get to see them: by and large ,we like them, and the categories they belong to, more (e.g., Monahan, Murphy, & Zajonc, 2000).

Attributions of agency

In a series of papers that examine the sense of authorship, that is – the degree to which people feel that they cause their own behavior – Aarts and colleagues have repeatedly shown that subliminal priming affected phenomenology. Thus, for example, priming of words related to success enhanced how much in control people felt, yet subliminal priming the word God decreased felt control (Aarts, 2007; Dijksterhuis, Preston, Wegner, & Aarts, 2008; see also Wenkea, Flemingb, & Haggardc, 2010).

Choice

Recent research documents effects of subliminal priming on choice. Thus, thirsty participants who had been subliminally primed with thirst-related words drank more than non primed participants (Strahan, Spencer, & Zanna, 2002). Extending these findings, Karremans et al. (2006) showed that thirsty participants, subliminally primed with a new brand name, tended to drink more of this brand (as compared to control participants).

Political Behavior

In yet another demonstration of the wide audiences that attune to subliminal stimuli, my colleagues and I have shown that subliminal priming of a national flag significantly changed political attitudes and voting intentions, changes that later affected how participants voted in real-life general elections (Carter, Ferguson, & Hassin, in press; Hassin, Ferguson, et al., 2009; Hassin, Ferguson, Shidlovsky, & Friedenberg, 2007).

Summary

The sections above bring a modest selection of recent advances in the study of subliminal priming. Semantic priming, effects of subliminal priming on control processes, felt affect, volition attribution, choices and political behavior, suggest that subliminal information gets a pretty big audience in our minds. This, in turn, suggests that the function of broadly broadcasting information is not uniquely conscious.

<div align="center">Function 4: Reasoning</div>

The family of processes subsumed under *reasoning* includes mental activities such as thinking, problem solving, decision making and planning (among others), each of which requires multiple fundamental functions. Intuition suggests an intimate relationship between reasoning and consciousness: The idea that one can reason without being aware that one is reasoning has an oxymoronish scent. Although this scent should have dissipated given the unconscious functions described in the previous sections, here I succinctly review some of the more direct evidence for non-conscious reasoning.

Inferences

Is there a grammatical error in the sentence: *John jumped from the 25th floor*? Is there one in *Ann's husband annoys her, so she decided to call her lawyer*? The answer, of course, is 'no'. But here is the real question: Did you think *suicide* when reading the first sentence? Did you consider *divorce* when reading the second? The literature suggests that even if you did not consciously experience these inferences, you had made them. Evidence from various corners of the cognitive sciences, using such paradigms as surprised cued recall, probe recognition, lexical decision, eye tracking, and cognitive load, suggests that the human mind makes causal inferences automatically and largely unconsciously. These inferences include predictions (McKoon & Ratcliff, 1986), traits (Todorov & Uleman, 2002; Uleman, Saribay, & Gonzales, 2008), goals (Hassin, Aarts, & Ferguson, 2005) and other causes (Hassin, Bargh, & Uleman, 2002). Recently it has been suggested that we can non-consciously conduct multiple inferences concurrently (Todd, Molden, Ham, & Vonk, 2011).

Insights and strategy discovery

Janet Metcalfe and her colleagues have successfully shown that insights – problem solving processes that end with a conscious 'aha' experience – can occur outside of conscious

awareness (Metcalfe, 1986; Metcalfe & Wiebe, 1987). To take just one example, in one of their experiments participants repeatedly rated how close they felt to solving insight vs. non-insight problems. In non-insight problems, ratings predicted solutions. In other words, participants were (at least partially) aware of the progress they made. This was not the case with insight problems: Participants could not reliably report progress. If one assumes that insights do not appear in consciousness from nowhere, then these data strongly suggest that functions related to problem solving can take place non-consciously.

In related research, Reder and colleagues have shown that while strategy shifts in problem solving might sometimes be conscious, the reasons that lead to them are often not (Reder & Schunn, 1996). Siegler and Stern (1998) have taken us one step forward, by showing that children *discover new strategies* for solving math equations, and *use* them, long before they can report these strategies.

Decision Making

Unconscious processes shape our intuitions, which often go uncontested to drive our decisions. Thus, unconscious processes are widely believed to indirectly determine many of our decisions (Ariely, 2008; Kahneman, 2011). These ideas fit nicely into the framework suggested by Nisbett and Wilson (1977), who argue that consciousness is often not privy to the mechanics of high level cognitive processes, but only to their products. In recent years Ap Dijksterhuis and his colleagues went one step further, by arguing that complicated decisions may even *benefit* from a period of time in which we engage in what they call *unconscious thought* (Dijksterhuis, Bos, Nordgren, & van Baaren, 2006; Payne, Samper, Bettman, & Luce, 2008).

These investigations were mainly of the unconscious cognition kind. A direct influence of subliminal stimuli on choice has been documented in research that was reviewed in previous sections of this paper.

Overcoming obstacles

The previous sections suggest that when reasoning goes well it can occur outside of conscious awareness. But what happens when we hit an obstacle, can we overcome it and change course[5]? In their influential work Bechara, Damasio and their colleagues pit the long term goal of their participants – to

---

[5] When the obstacle is ignorance, overcoming obstacles requires learning the structure of environment. Implicit learning – that is, learning without awareness – is a well-established process that unfortunately lies beyond the scope of the current paper (e.g., Reber, 1993)

gain as much money as they can – against a short term obstacle: immediate high gains (Bechara, Damasio, Tranel, & Damasio, 1997). They show that although participants are initially attracted to choices that yield immediate high gains (yet lower expected utilities), they can overcome this attraction without consciously realizing that they do (but see Maia & McClelland, 2004). Similarly, Fishbach and her colleagues (Fishbach, Friedman, & Kruglanski, 2003) have shown that when obstacles to self control (e.g., television) are subliminally primed, they can activate the higher order goal (e.g., learning).

More generally, building on their earlier work (Patterson & Mischel, 1976), and on the work of Gollwitzer and colleagues (Gollwitzer, 1999), Mischel and Ayduk (Mischel & Ayduk, 2004) argue that self control – the function that allows us to overcome obstacles to our more important goals – can become automatic and unconscious (see also Hassin, Aarts, Eitam, Custers, & Kleiman, 2009).

So… What Can It?

In operational terms, the recipe for examining whether a cognitive operation (or a set of operations) can or cannot take place non-consciously is simple: One needs to strip a the operation into its elemental basic-level *functions* and then come up with an experimental design that (a) tests the *functions,* while (b) *allowing* the processes to occur non-consciously (or even preventing them from becoming conscious).

The latter part is crucial, yet many paradigms neglect it, thereby creating various demands for awareness. When these demands are removed, as in the studies described above, the real powers of the unconscious may be revealed. In fact, the list of demonstrations discussed above is far from exhaustive. The function of *extracting patterns from our environment*, also known as implicit learning, has been repeatedly demonstrated (Reber, 1976); maintaining evidence from past experience, also known as *memory*, can happen outside of conscious awareness (Schacter, 1987); people can *extract information about emotional and gender* from subliminally presented facial expressions (Jiang, Costello, Fang, Huang, & He, 2006; Yang, Zald, & Blake, 2007); *comparing oneself with others*, a central social function, occurs non-consciously, and even with subliminally presented others (Mussweiler & Damisch, 2008; Stapel & Blanton, 2004), and physical sensations affect perception (Proffitt, 2006) and social perception (Ackerman, Nocera, & Bargh, 2010; Williams & Bargh, 2008)) with no apparent effect on phenomenology. The list can go on but these examples are numerous enough to make a simple point: A review of the literature through functional glasses quickly reveals that many functions that were historically associated with conscious awareness can occur non-consciously.

Now think of your preferred fundamental $F_{current}$, that is – the function that *you* think cannot be performed unconsciously. As long as it is fundamental YIC predicts that this function, too, can be performed unconsciously. This prediction rests on two foundations: The a-priori reasons to believe in YIC (briefly reviewed in the Introduction), and the impressive list of demonstrations of unconscious functions reviewed in later sections.[6] This is by no way a valid logical induction, but it is, I believe, a plausible psychological argument.

<center>And…When Can It?</center>

Good sprint runners can run 100 meters in less than ten seconds, but more often than not they choose not to. Similarly, the assertion that the unconscious *has the ability* to perform a function F does not imply that the unconscious always performs F, not even that it frequently does so. It is a statement about abilities, not actualities. To learn more about the actualities one has to ask herself *when* can we expect the unconscious to perform F? In the case of sprint runners, the likelihood that they will run 100 meters in less than ten seconds increases with their practice, motivation, and basic abilities. In the current section I propose that the same answer applies to the question of when is it likely that the unconscious will perform F.

Practice

The vast automatization literature (e.g., Bargh, 1994; Kahneman & Treisman, 1984; Schneider & Shiffrin, 1977) suggests that the more automatic a process becomes, the more likely it is to occur effortlessly and unconsciously. In one of the most striking demonstrations of the powers of automatization, Spelke and colleagues (Spelke, Hirst, & Neisser, 1976) trained students to read short stories while writing lists of words at dictation. After 17 weeks of five hours training a day (!), these students could read a story while writing dictated words, categorizing them, and detecting relations amongst them. While data for awareness during this specific study is equivocal, they do suggest that the students became unaware of performing the dictation-related tasks. This striking result is but one of many similar findings, which strongly suggest that as F becomes automatic, it is more likely to recede from consciousness. One implication of this finding is that we should expect within individual

---

[6] Rozin (1976) suggested that our capacities in general, and conscious capacities in particular, are built on "subprograms" that are themselves unconscious. If I am not mistaken this view should make the same predictions YIC makes: that for every F there exist a context, and content, such that F can be accomplished non-consciously.

developmental trajectories in the capabilities of the unconscious, that will result in *large individual differences* in the capacity of the unconscious.

Motivation

The likelihood that a function F will be accomplished non-consciously should increase with motivation (implicit, explicit or both). Direct evidence for the role of motivation and needs in non-conscious processes comes from recent investigations of subliminal persuasion. Strahan, Spencer, & Zanna (2002) showed that subliminal primes affect consumption, but only in the presence of a relevant physical need (such as thirst). Extending these findings, it was demonstrated that priming thirsty (but not non-thirsty) people with a subliminal *brand* of beverage increased the likelihood that they choose to drink this brand (Karremans et al., 2006). Similar findings were reported by Bermeitinger et al.(2009), showed that subliminal priming affects choice of dextrose pills only when one has to overcome fatigue. Finally, my colleagues and I showed that implicit motivation to succeed improves implicit learning (Eitam, Hassin, & Schul, 2008), and that it strengthens the effect of subliminal primes on choice (Milyavsky, Schul, & Hassin, 2011).

Indirect support for the role of motivation in non-conscious goal pursuit comes from comparing the more cognitive literature on the unconscious to the more social-cognitive one. One of the differences between these two literatures is that social cognitive scientists tend to investigate 'hot' issues such as goals, emotions, stereotypes and attitudes, whereas more cognitive cognitive scientists attend to 'colder' issues such as semantics and categorization. Interestingly, the debate on semantic subliminal priming lasted for almost two and a half decades (roughly from Marcel (1983), to Kouider and Dehaene (2007)), yet in the same decades scientists in the social cognition tradition subliminally primed stereotypes and attitudes, as well as other motivationally-meaningful stimuli (e.g., Bargh & Pietromonaco, 1982; Devine, 1989). While there are many differences between these literatures, one tentative conclusion might be that the unconscious is likely to engage in motivationally relevant and interesting issues (such as goals, stereotypes and incentives) more than in motivationally-irrelevant and less interesting issues (such as the relations between chairs and tables).

In light of the direct and indirect evidence presented above it seems reasonable to suggest that one needs to motivate the unconscious to perform tasks, in the same way that one needs to motivate consciousness to engage in effortful processing. The more motivation there is, the more likely it is that the unconscious will perform a given task.

Ability

Working memory capacity and related constructs such as executive functions are important determinants of high-level, mostly conscious, cognition (Conway et al., 2005; Redick, Heitz, & Engle, 2007; Ricks, Turley-Ames, Wiley, McVay, & Kane, 2007). We have recently shown that working memory can also operate outside of conscious awareness (Hassin, 2005; Hassin, Bargh, Engell, et al., 2009), and we and others have shown that executive functions are intertwined with non-conscious processes (see Function 3 above; see also Hassin, Bargh, & Zimerman, 2009). It seems reasonable, then, to expect that implicit working memory capacity and executive functions play a significant role in determining the abilities of the unconscious, in the same way that explicit working memory and executive functions are important determinants of conscious processes. The more capacity one has, the more likely it is that her unconscious will be able to perform a given high level cognitive process. Since conscious and unconscious processes usually interact in producing cognition, it is likely that implicit and explicit capacity play a causal role both in conscious and unconscious processes.

Lastly, are these enabling conditions dangerous, in the sense that every failure to demonstrate F non-consciously can be explained away as a failure of meeting these conditions? I believe that the answer should be negative. Take, for example, the subliminal priming literature. We are willing to accept that a process is subliminal when researchers thoroughly look for indications of awareness, and fail to find them. The same should be true here. We should be willing to accept failures of non-conscious processes when we are convinced that the researchers had made serious attempts to allow for non-conscious processing to happen.

A Walk through a Garden of Objections

Upon reading this article many are likely to object by coming up with their own examples to functions that cannot occur non-consciously. I know, because I have encountered many of these objections during talks and conversations. In order to see the potential benefits of YIC and the functional approach, let us walk through an example that is based on a series of conversations I had with a senior cognitive scientist, NP. NP thought that one of the functions that the unconscious cannot perform is arithmetic. Fortunately, this is a tractable question given modern technology: One can run a study in which instances of $Z - Y =$ are primed subliminally (e.g., 9-6=), and examine whether the result of the equation is activated. We actually ran an experiment of this sort, and it worked: The solution of

equations, that were not presented to subjects, were primed by the subliminal equations (Sklar & Hassin,2011).

Was NP convinced? Not really. "Oh, well," he said, "these kinds of equations are automatized in second grade. But how about equations with three numbers? Can you run a study in which you examine whether *X-Y-Z* can be solved unconsciously?" "Well," I replied, "we actually ran a study of this sort, and it worked too."

Was NP persuaded? The answer is mixed. He seemed to be slightly impressed, but still not entirely convinced. "How about 17 x 24?" – he asked next. Well, we didn't run this study (yet). Most people find it difficult to compute the answer, and following the principles identified above, we would need to motivate the unconscious to solve these equations. This is hardly surprising, because without incentives people do not tend to find answers to these kinds of questions even when the numbers appear explicitly on their desktop.[7] Another way of examining his question, following the third principle suggested above, is to examine mathematicians, who find math inherently interesting and challenging. It is more likely that they will solve these kinds of equations unconsciously.

Note, that NP wanted to see evidence for non-conscious arithmetic. Then, he wanted to see evidence from arithmetic that was not overlearnt. And then, he wanted to see arithmetic that is *really difficult*. From the functional perspective adopted here, *really difficult* arithmetic is not different from *easy* arithmetic (given the same operations). Hence, the second experiment described above should allow us to conclude that the unconscious can do arithmetic. If the unconscious then fails (say) to solve *really difficult subtraction* then YIC and the functional approach send us to a different route, one of examining *difficulty*, not *arithmetic* per se.

There are a few lessons we can learn from my exchange with NP. First, that persuading people that the unconscious is not more functionally debilitated than consciousness (as far as high level cognition goes) is not an easy task. Second, that YIC and the functional stance give us tools to make predictions and shape experiments.

On Consciousness

---

[7] Have you consciously found a solution by now? Why haven't you? The question, you may think to yourself, is why should you bother. This is the same kind of question your unconscious may ask itself, and it may give itself the same kind of answer.

In Marr's terminology YIC suggests that *computationally* conscious and unconscious processes are similar (for fundamental functions). This does not mean, however, that there are no differences in the *algorithmic and implementational levels*. In other words, YIC is compatible with the idea that unconscious functions may sometimes be carried out in different ways, using different representations, and via different brain networks. This idea is in no way new (e.g., Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006; Norman & Shallice, 1986; Reber, 1992; Tulving & Schacter, 1990; for a review see Holyoak & Spellman, 1993). Historically, these differences were associated with the separate functions of conscious vs. unconscious processes (but see Rozin, 1976). The novelty here is the postulation that *the same functions* can be carried out consciously and non-consciously, and that their cognitive and brain implementations may sometimes differ. This postulation should not be taken to imply that there are two different and distinct mind/brain systems – one conscious the other is not – that perform cognitive functions independently of each other (see also footnote 1). This multitude of minds/brains seems unlikely given what we know about evolutionary pressures. Conscious awareness, rather, is seen here as a contingent property of fundamental functions.

On Zombies and Humans

Consciousness is a sensitive issue. We are all very attached to our private consciousness, and we (want to) believe that it plays an important causal role in our lives. YIC, or the postulation that consciousness is not necessary for F, for all Fs that are fundamental functions, does not necessarily mean that this belief is false, or that consciousness is an epiphenomenon. In the language of philosophers of mind, YIC does not mean that we can't tell a zombie from its conscious identical twin. In the following paragraph I describe two possible types of differences between these siblings (obviously, the list is much longer).

First, because conscious and unconscious functions may play out differently, they are likely to be differences between the conscious and unconscious pursuit of the same function. Consider, for example, a participant who sees feedback on the monitor, informing her that, based on her performance on previous tasks, the experimenter believes that she is the modern equivalent of Einstein. It seems reasonable to expect that this student will feel, think and behave (very) differently from a participant who sees the same feedback subliminally. So even if one assumes, for the sake of the argument, that humans can non-consciously read and process feedback, whether or not these processes are accompanied by conscious awareness is likely to lead to differences.

Second, in a section above (*And… When Can It*) I listed factors that increase the likelihood that a non-conscious process would kick in. I see no reason to assume that the enabling conditions for conscious Fs would be identical to those of non-conscious Fs. In other words, while under some conditions both the Zombie and her sister will carry out F (unconsciously and consciously, respectively), under other conditions the conscious twin may carry out functions that the Zombie would not, or even carry F both consciously and unconsciously. These differences are likely to affect the outcomes.

To be (a Zombie) or not to be?

Given the hypothesized differences in how conscious and unconscious processes play out, and in their enabling conditions, it seems unlikely that they would be equally good for every function F. Existing research provides initial support for this idea. In the area of learning, for example, it has been shown that unconscious processes have an advantage when one learns complicated rules (Berry & Broadbent, 1988; Halford, Baker, McCredden, & Bain, 2005). Processes that are accompanied by consciousness, on the other hand, do better at following task-switch cues (van Gaal, Ridderinkhof, et al., 2010), and there are also interesting differences in incentive processing (Bijleveld, Custers, & Aarts, 2012)**.**

In general, I think, the *Who Wins* question is likely to receive qualified answers: Under certain circumstances and constraints Conscious F is better than Unconscious F, and in other circumstances it may be the other way around. Consider monitoring of mental contents, a function that is known to occur both consciously (Morewedge & Kahneman, 2010) and unconsciously (Wegner, 1994). Capacity considerations – how many resources does a task requires vs. how many are available – are likely to render one sort of monitoring more efficient than another. How, why, and in what ways do conscious and unconscious processes that implement the same functions differ, is an exciting empirical question that awaits further data.

Coda

I would like to end this paper by noting that the structure of the modern discussion on the unconscious and the functions of consciousness is such that scientists who wish to argue that a function F can occur without awareness are usually asked, and rightfully so, to provide stringent empirical support. Often, no such support is requested when one argues that F requires consciousness. This unbalanced state of affairs suggests that the default view is that there are many high level cognitive functions that unconscious processes cannot perform (e.g., Loftus & Klinger, 1992). As research has

repeatedly shown (e.g., Johnson & Goldstein, 2003; Samuelson & Zeckhauser, 1988), defaults are of utmost importance in decision making. In similar ways, defaults are crucial in the advancement of science. Changing defaults has the potential of releasing constraints from our exploration space and shedding new light on existing data and theories. It is my hope, then, that the current paper will help bring about a change in the default mode of thinking about the abilities of the unconscious.

Author's Note:

References

Aarts, H. (2007). Unconscious authorship ascription: The effects of success and effect-specific information priming on experienced authorship. *Journal of experimental social psychology, 43*, 119-126.

Aarts, H., Gollwitzer, P., & Hassin, R. R. (2004). Goal Contagion: Perceiving is for pursuing. *Journal of Personality and Social Psychology, 87*(1), 23-37.

Ackerman, J. M., Nocera, C. C., & Bargh, J. A. (2010). Incidental haptic sensations influence social judgments. *Science, 328*, 1712-1715.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ariely, D. (2008). *Predictably irrational : the hidden forces that shape our decisions*. New York, NY: Harper.

Baars, B. J. (1997). *In the theater of consciousness: The workspace of the mind*. London: Oxford University Press.

Baars, B. J., & Franklin, S. (2003). How conscious experience and working memory interact. *Trends in cognitive science, 7*(4), 166-172.

Baddeley, A. D. (2000). The episodic buffer: a new component of working memory? *Trends in Congnitive Sciences, 4*(11), 417-423.

Baddeley, A. D. (2007). *Working memory, Thought, and Action*. New York: Oxford University Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Upper Saddle River, NJ: Prentice-Hall.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R. J. Wyer & T. K. Srull (Eds.), *Handbook of social cognition* (pp. 1-40). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Bargh, J. A. (2007). *Social psychology and the unconscious: The automaticity of higher mental processes*. Philadelphia: Psychology Press.

Bargh, J. A. (Ed.). (2007). *Social psychology and the unconscious: The automaticity of higher mental processes*. New York: Psychology Press.

Bargh, J. A., Gollwitzer, P., Lee-Chai, A., Barndollar, K., & Troetschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81*(6), 1014-1027.

Bargh, J. A., & Morsella, E. (2008). The unconscious mind. . *Perspectives on Psychological Science, 3*, 73-79.

Bargh, J. A., & Pietromonaco, P. (1982). Automatic information processing and social perception: The influence of trait information presented outside of conscious awareness on impression formation. *Journal of Personality and Social Psychology, 43*(3), 437-449.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding Advantageously Before Knowing the Advantageous Strategy. *Science, 275*(5304), 1293-1295.

Bermeitinger, C., Goelz, R., Johr, N., Neumann, M., Ecker, U. K. H., & Doerr, R. (2009). The hidden persuaders break into the tired brain. *Journal of experimental social psychology, 45*(2), 320-326.

Berry, D. C., & Broadbent, D. E. (1988). Interactive tasks and the implicit-explicit distinction. *British Journal of Psychology, 79*, 251-272.

Bijleveld, E., Custers, R., & Aarts, H. (2010). Unconscious reward cues increase invested effort, but do not change speed-accuracy tradeoffs. *Cognition, 115*, 330.

Bijleveld, E., Custers, R., & Aarts, H. (2012). Adaptive Reward Pursuit: How Effort Requirements Affect Unconscious Reward Responses and Conscious Reward Decisions. *Journal of experimental psychology. General, in press*.

Brewer, M. B., & Kramer, R. M. (1986). Cohice behavior in social dilemmas: Effects of social identity, group size, and decision framing. *Journal of Personality and Social Psychology, 50*, 543-549.

Carter, T. J., Ferguson, M. J., & Hassin, R. R. (in press). A Single Exposure to the American Flag Shifts Support Toward Republicanism up to 8 Months Later *Psychological Science, in press*.

Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrik, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic Bulletin and Review, 12*, 769-786.

Custers, R., & Aarts, H. (2010). The unconscious will: How the pursuit of goals operate outside of conscious awareness. *Science, 329*, 47-50.

De Gelder, B., de Haan, E. H. F., & Heywood, C. A. (2001). *Out of mind: Varieties of unconscious processes*. London: Oxford University Press.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality, 19*(2), 109-134.

Dehaene, S., Changeux, J. P., Naccache, L., Sackur, J., & Sergent, C. (2006). Conscious, preconscious, and subliminal processing: A testable taxonomy. *Trends in Cognitive Science, 10*(5), 203-211.

Dehaene, S., & Naccache, L. (2001). Towards a cognitive neuroscience of consciousness: basic evidence and a workspace framework. *Cognition, 79*(1-37).

Dennett, D. C. (1995). *Darwin's Dangerous Idea: Evolution and the meaning of life*. New York: Simon and Schuster.

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology, 56*(1), 5-18.

Dienes, Z., & Seth, A. (2010). Gambling on the unconscious: A comparison of wagering and confidence ratings as measures of awareness in an artificial grammar task. *Consciousness and Cognition, 19*(2), 674-681.

Dijksterhuis, A., & Aarts, H. (2010). Goals, attention, and (un)consciousness. *Annual Review of Psychology, 61*, 467-490.

Dijksterhuis, A., Bos, M. W., Nordgren, L. F., & van Baaren, R. B. (2006). On Making the Right Choice: The Deliberation-Without-Attention Effect. *Science, 311*(5763), 1005-1007.

Dijksterhuis, A., Preston, J., Wegner, D. M., & Aarts, H. (2008). Effects of subliminal priming of self and god on self-attribution of authorship for events. *Journal of experimental social psychology, 44*, 2-9.

Eitam, B., Hassin, R. R., & Schul, Y. (2008). Nonconscious goal pursuit in novel environments: The case of implicit learning. *Psychological Science, 19*, 261-267.

Fehr, E., & Fischbacher, U. (2003). The nature of human altruism. *Nature, 425*, 785-791.

Fishbach, A., & Ferguson, M. J. (2007). The goal construct in social psychology. In A. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles*. New York: Guilford Press.

Fishbach, A., Friedman, R. S., & Kruglanski, A. W. (2003). Leading Us Not Unto Temptation: Momentary Allurements Elicit Overriding Goal Activation. *Journal of Personality and Social Psychology, 84*(2), 296 - 309.

Gawronski, B., & Payne, B. K. (2010). *Handbook of Implicit Social Cognition: Measurement, Theory, and Applications* New York: Guilford Press.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*, 493-503.

Greenwald, A. G. (1992). New Look 2: Unconscious cognition reclaimed. *American Psychologist, 47*, 766-779.

Halford, G. S., Baker, R., McCredden, J. E., & Bain, J. D. (2005). How many variables can humans process? *Psychological science, 16*, 70-76.

Hassin, R. R. (2005). Non-conscious control and implicit working memory. In R. R. Hassin, J. S. Uleman & J. A. Bargh (Eds.), *The New Unconscious* (pp. 196-225). New York: Oxford university press.

Hassin, R. R., Aarts, H., Eitam, B., Custers, R., & Kleiman, T. (2009). Non-Conscious Goal Pursuit and the Effortful Control of Behavior. In E. Morsella, P. M. Gollwitzer & J. A. Bargh (Eds.), *Oxford Handbook of Human Action* (pp. 549-586). New York: Oxford University Press.

Hassin, R. R., Aarts, H., & Ferguson, M. J. (2005). Automatic goal inferences. *Journal of Experimental Social Psychology, 41*, 129-140.

Hassin, R. R., Bargh, J. A., Engell, A., & McCulluch, K. C. (2009). Implicit Working Memory. *Consciosness and Cognition, 18*(665-678).

Hassin, R. R., Bargh, J. A., & Uleman, J. S. (2002). Spontaneous causal inferences. *Journal of Experimental Social Psychology, 38*, 515-522.

Hassin, R. R., Bargh, J. A., & Zimerman, S. (2009). Automatic and flexible: The case of non-conscious goal pursuit. *Social Cognition, 27*(1), 20-36.

Hassin, R. R., Ferguson, M. J., Kardosh, R., Porter, S. C., Carter, T. J., & Dudareva, V. (2009). Précis of Implicit Nationalism. *Annals of the New York Academy of Sciences, 1167*(1), 135-145.

Hassin, R. R., Ferguson, M. J., Shidlovsky, D., & Friedenberg, T. (2007). Subliminal exposure to national flags affects political thought and behavior. *Proceedings of the national academy of science of the United States of America, 104*, 19757-19761.

Hassin, R. R., Uleman, J. S., & Bargh, J. A. (Eds.). (2005). *The New Unconscious*. New York: Oxford university press.

Jiang, Y., Costello, P., Fang, F., Huang, M., & He, S. (2006). A gender- and sexual orientation-dependent spatial attentional effect of invisible images. *Proceedings of the National Academy of Sciences, 103*(45), 17048-17052.

Johnson, E. J., & Goldstein, D. G. (2003). Do Defaults Save Lives? *Science, 302*, 1338-1339.

Kahneman, D. (1973). *Attention and Effort*. Englewoods Cliff, NJ: Prentice-Hall.

Kahneman, D. (2011). *Thinking, Fast and Slow*. London, England: Penguin Books.

Kahneman, D., & Treisman, A. (1984). Changing views of attention and automaticity. In R. Parasuraman & D. Davies (Eds.), *Varieties of attention* (pp. 29-61). New York: Academic Press.

Karremans, J. C., Stroebe, W., & Claus, J. (2006). Beyond Vicary's fantasies: The impact of subliminal priming and brand choice. *Journal of experimental social psychology, 42*(6), 792-798.

Keren, G., & Schul, Y. (2009). Two is not always better than one: A critical evaluation of two-system theories. *Perspectives on Psychological Science, 4*, 533-550.

Kintsch, W., Healy, A., Hegarety, M., Pennington, B., & Salthouse, T. (1999). Eight questions and some general issues. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 412 -441). New York, NY: Cambridge University Press.

Kleiman, T., & Hassin, R. R. (2011). Nonconscious goal conflict. *Journal of experimental social psychology, 47*, 521-532.

Kouider, S., & Dehaene, S. (2007). Levels of processing during non-conscious perception: a critical review of visual masking. *Philosophical Transactions of the Royal Society B Biolgical Sciences, 362*, 857-875.

Lau, H. C., & Passingham, R. E. (2007). Unconscious Activation of the Cognitive Control System in the Human Prefrontal Cortex. *The Journal of Neuroscience, 27*(21), 5805-5811.

Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting & task performance*. Upper Saddle River, NJ: Prentice-Hall, Inc.

Maia, T. V., & McClelland, J. L. (2004). A reexamination of the evidence for the somatic marker hypothesis: what participants really know in the Iowa gambling task. *Proceedings of the National Academy of Sciences of the United States of America, 101*, 16075-16080.

Maljkovic, V., & Nakayama, K. (1994). Priming of pop-out: I. Role of features. *Memory and Cognition, 22*(6), 657-672.

Marcel, A. J. (1983). Conscious and unconscious perception: An approach to the relations between phenomenal experience and perceptual processes. *Cognitive Psychology, 15*(2), 238-300.

Marr, D. (1982). *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. New York: W H Freeman & Co.

McKone, E. (1995). Short Term implicit memory for words and nonwords. *Journal of experimental psychology: Learning, memory and cognition, 21*(5), 1108-1126.

McKoon, G., & Ratcliff, R. (1986). Inferences about predictable events. *Journal of Experimental Psychology: Learning, Memory and Cognition, 12*(1), 82-91.

Meiran, N. (2010). Task switching: Mechanisms underlying rigid vs. flexible self control. In R. R. Hassin, K. Ochsner & Y. Trope (Eds.), *Self control in society, mind and brain*. New York: Oxford University Press.

Metcalfe, J. (1986). Feeling of knowing in memory and problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*(2), 288-294.

Metcalfe, J., & Wiebe, D. (1987). Intuition in insight and noninsight problem solving. *Memory and Cognition, 15*, 238-246.

Milyavsky, M., Schul, Y., & Hassin, R. R. (2011). Motivation Boosts the Influence of Subliminal Information on Choice. *In Preparation*.

Mischel, W., & Ayduk, O. (2004). Willpower in a cognitive-affective processing system: the dynamics of delay gratification. In R. F. Baumeister & K. D. Vohs (Eds.), *Handbook of self regulation: Research, theory, and applications* (pp. 99-129). New York: Guilford Press.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. A., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49-100.

Monahan, J. L., Murphy, S. T., & Zajonc, R. B. (2000). Subliminal mere exposure: Specific, General, and Diffuse effects. *Psychological Science, 11*, 462-466.

Morewedge, C. K., & Kahneman, D. (2010). Associative processes in intuitive judgment. *Trends in Cognitive Sciences 14*, 435–440.

Mussweiler, T., & Damisch, L. (2008). Going back to Donald: How comparisons shape judgmental priming effects. *Journal of Personality and Social Psychology, 95*(6), 1295-1315.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*(231-259).

Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In J. R. Davidson, G. E. Schwartz & D. Shapiro (Eds.), *Consciousness and self regulation: advances in research and theory* (Vol. 4, pp. 1-18). New York: Plenum Press.

Overgaard, M., Timmermans, B., Sandberg, K., & Cleeremans, A. (2010). Optimizing subjective measures of consciousness. *Consciousness and Cognition, 19*(2), 682-684.

Patterson, C. J., & Mischel, W. (1976). Effects of temptation-inhibiting and task-facilitating plans on self-control. *Journal of Personality and Social Psychology, 33*, 209-217.

Payne, J. W., Samper, A., Bettman, J. R., & Luce, M. F. (2008). Boundary conditions on unconscious thought in complex decision making. *Psychological Science, 19*, 1118-1123.

Pessiglione, M., Schmidt, L., Draganski, B., Kalisch, R., Lau, H., Dolan, R. J., et al. (2007). How the Brain Translates Money into Force: A Neuroimaging Study of Subliminal Motivation. *Science, 316*(5826), 904-906.

Proffitt, D. R. (2006). Embodied Perception and the Economy of Action. *Perspectives on Psychological Science, 1*(2), 110-122.

Reber, A. S. (1992). The Cognitive Unconscious - an Evolutionary Perspective. *Consciousness and Cognition, 1*(2), 93-133.

Reber, A. S. (1993). *Implicit Learning and Tacit Knowledge: An Essay on the Cognitive Unconscious*. London: Oxford University Press.

Reder, L. M. (1996). *Implicit Memory and Metacognition*: Lawrence Erlbaum Associates.

Reder, L. M., & Schunn, C. D. (1996). Metacognition does not imply awareness: Strategy choice is governed by implicit learning and memory. In L. M. Reder (Ed.), *Implicit Memory and Metacognition*. Mahwan, NJ: Erlbaum.

Redick, T. S., Heitz, R. P., & Engle, R. W. (2007). Working memory capacity and inhibition: Cognitive and social consequences. In D. S. Gorfein & C. M. MacLeod (Eds.), *Inhibition in cognition.* (pp. 125): American Psychological Association: Washington.

Ricks, T. R., Turley-Ames, K. J., Wiley, J., McVay, J. C., & Kane, M. J. (2007). Effects of working memory capacity on mental set due to domain knowledge

Conducting the train of thought: Working memory capacity, goal neglect, and mind wandering in an executive-control task. *Memory & Cognition, 35*(6), 1456.

Rosch, E., Mervisa, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8*(3), 382-439

Rozin, P. (1976). The evolution of intelligence and access to the cognitive unconscious. *Progress in psychobiology and physiological psychology, 6*, 245-280.

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty, 1*, 7-59.

Schacter, D. L. (1987). Implicit Memory - History and Current Status. *Journal of Experimental Psychology-Learning Memory and Cognition, 13*(3), 501-518.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review, 84*(1), 1-66.

Siegler, R. S., & Stern, E. (1998). Conscious and unconscious strategy discoveries: A microgenetic analysis. *Journal of Experimental Psychology: General, 127*, 377-397.

Spelke, E., Hirst, W., & Neisser, U. (1976). skills of devided attention. *cognition, 4*, 215-230.

Stapel, D. A., & Blanton, H. (2004). From seeing to believing: Subliminal social comparisons affect implicit and explicit self-evaluations. *Journal of Personality and Social Psychology, 87*(4), 468 – 481.

Strahan, E. J., Spencer, S. J., & Zanna, M. P. (2002). Subliminal priming and persuasion: Striking while the iron is hot. *Journal of experimental social psychology, 38*(6), 556-568.

Todd, A. R., Molden, D. C., Ham, J., & Vonk, R. (2011). The automatic and co-occurring activation of multiple social inferences. *Journal of Experimental Social Psychology, 47*, 37-49.

Todorov, A., & Uleman, J. S. (2002). Spontaneous trait inferences are bound to actors' faces: Evidence from a false recognition paradigm. *Journal of Personality and Social Psychology, 83*(5), 1051-1065.

Tulving, E., & Schacter, D. L. (1990). Priming and Human-Memory Systems. *Science, 247*(4940), 301-306.

Uleman, J. S., Saribay, S. A., & Gonzales, C. M. (2008). Spontaneous inferences, implicit impressions, and implicit theories. *Annual Review of Psychology, 59*, 329-360.

Underwood, G. (1996). *Implicit Cognition*. Oxford: Oxford University Press.

Van den Bussche, E., Van den Noortgate, W., & Reynvoet, B. (2009). Mechanisms of masked priming: A meta analysis. *Psychological Bulletin, 135*(452-477).

van Gaal, S., Lamme, V. A. F., Fahrenfort, J. J., & Ridderinkhof, K. R. (2010). Dissociable brain mechanisms underlying the conscious and unconscious control of behavior. *Journal of cognitive neuroscience, 23*, 91-105.

Van Gaal, S., Ridderinkhof, K. R., Johannes, J. F., Scholte, S., & Lamme, V. A. F. (2008). Frontal Cortex Mediates Unconsciously Triggered Inhibitory Control. *The Journal of Neuroscience, 28*(32), 8053-8062.

van Gaal, S., Ridderinkhof, K. R., Scholte, S. H., & Lamme, V. A. F. (2010). Unconscious activation of the prefrontal no-go network. *Journal of Neuroscience, 30*(4143-4150).

Wegner, D. M. (1994). Ironic Processes of Mental Control. *Psychological Review, 101*(1), 34-52.

Wegner, D. M., & Vallacher, R. R. (1977). *Implicit Psychology: An Introduction to Social Cognition*. New York: Oxford University Press.

Wenkea, D., Flemingb, S. M., & Haggardc, P. (2010). Subliminal priming of actions influences sense of control over effects of action *Cognition, 115*(1), 26-38

Williams, L. E., & Bargh, J. A. (2008). Experiencing physical warmth promotes interpersonal warmth. *Science, 322*, 606-607.

Wilson, T. D. (2002). *Strangers to Ourselves: Discovering the Adaptive Unconscious*. Cambridge, MA: Harvard University Press.

Wittgenstein, L. (1963). *Philosophical Investigations (translated by G. Anscombe)*. New York: Macmillan.

Yang, e., Zald, D. H., & Blake, R. (2007). Fearful Expressions Gain Preferential Access to Awareness During Continuous Flash Suppression. *Emotion, 7*(4), 882–886.