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Unconscious Goal Activation and the Hijacking of the Executive Function

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Building on research on unconscious human goal pursuit and the dynamic nature of our mental and physical world, this study examined the idea that an unconsciously activated goal hijacks executive control for its own attainment. This "hijacking" of the executive function by an unconscious goal should be evidenced by impaired performance on an unrelated task relying on executive control. The results of 6 experiments show that subliminal activation of a socializing goal, or an idiosyncratic personal goal, or an academic goal, harmed participants' performance on an executive function task, such as inhibition of prepotent responses and detection of text errors during reading. These effects were unique to executive control, were similar when the goal was activated consciously, and were independent of task motivation and perceived inter-goal relatedness between the primed goal and task goal. Furthermore, an unconscious goal occupied executive control to advance itself more strongly when the goal had personal value. Implications for theory and research on unconscious goal pursuit and the executive function are discussed.

Keywords: unconscious goal pursuit, executive function, subliminal priming

Many of our behaviors are determined by goals that we wish to attain in the future. Attaining our goals is not always easy: It often requires that we resist distractions and adapt to new and changing environments. Thus, goal pursuits are generally assumed to rely on executive functions that allow us to be focused on our means and goals, and to alter our behaviors in response to changes in the environment (Miyake & Shah, 1999; Smith & Jonides, 1998). The modal view assumes that humans consciously set their goals and control their behavior; hence, the organization and control of goal-directed behavior is mainly studied as the product of the conscious mind (Bandura, 1986; Locke & Latham, 1990; Monsell & Driver, 2000). However, in the last decade it has been repeatedly demonstrated that goals can be activated and pursued unconsciously (Bargh, Gollwitzer, & Oettingen, 2010; Custers & Aarts, 2010). These findings raise the important and intriguing question of whether unconscious goals also engage executive control processes.

Although previous research supports the idea that goal pursuit can be triggered outside of a person's awareness, the evidence speaking for the human ability to recruit executive control processes upon the unconscious activation of a goal is still received with some reservation. An important reason for this pertains to the notion that executive functioning is suggested to require consciousness (Baars & Franklin, 2003), and hence it is simply not possible to recruit these processes unconsciously. In addition, unconscious goals are assumed to operate in an effortless fashion, whereas executive control requires mental resources. Both assumptions are dominant in the social psychology literature (Baumeister, Schmeichel, & Vohs, 2007; Kruglanski & Köpetz, 2009), and they concur with the general debate on the role of consciousness in executive control (Dehaene & Changeux, 2011; Lau & Rosenthal, 2011; Suhler & Churchland, 2009).

The present research aims to significantly advance the study of unconscious goal pursuit by examining whether unconscious goals occupy executive control for their own attainment. Whereas earlier research suggests that unconscious goal pursuit is associated with executive functions by examining their contributions to the pursuit, here we adopt a new and clearer method and propose that executive functions are immediately being "hijacked" upon the activation of unconscious goals. Specifically, we rely on the assumption that executive control has limited capacity (Kahneman, 1973; Navon, 1984; Pashler, 1998), and we assume that unconsciously activated goals recruit executive control that renders the capacity for control less available for other tasks that require them. Thus, performance on these tasks should be impaired while the unconscious goal is hijacking control for its own attainment. We report six experiments to test this idea by using subliminal presentation methods and different executive control tasks that should be sensitive to impairment as a result of the occupation of executive control by unconscious goals. Establishing support for this idea

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would speak against the notion that executive control processes can only be recruited by conscious goals and that unconscious goals merely rely on effortless processes.

Unconscious Goal Pursuits: Do They Involve Executive Control?

Goals motivate and guide behavior in the service of attaining desired outcomes (Carver & Scheier, 1998; Gollwitzer & Moskowitz, 1996). This general view on the regulatory power of goals underlying human behavior is well-accepted, and recent research offers a specific analysis of the executive control processes that are proposed to facilitate goal attainment (Funahashi, 2001; Miyake & Friedman, 2012; Smith & Jonides, 1999). In research on executive control, it is often assumed that the brain is a noisy device and that humans have to deal with the inherently dynamic nature of their mental and physical world (Lau & Rosenthal, 2011). Therefore, once a goal is in place, people recruit a specific set of operations that render cognition and action stable and adaptive over time. In general, executive control processes enable efficient goal pursuit via (1) holding goal-relevant information (e.g., the goal itself, means) active in mind for a critical period of time; (2) inhibiting interfering information, whether internal or external; and (3) monitoring the current state of goal pursuit and processing feedback information to adjust behavior in response to potential discrepancies.

Most research on the role of goals in recruiting executive control processes employ experimental procedures to isolate specific functions of executive control by instructing participants to consciously set a task goal and to work on consciously processed task-related information to attain their goal (Miyake & Friedman, 2012). This research is often taken as proof that executive control relies on consciousness, as the recruitment of executive control results from conscious attention to goals (e.g., Baars & Franklin, 2003; Baddeley, 1993). While this suggestion fits well with people's conscious experience of the goals they pursue, recently it has been proposed that attention and consciousness are distinctive aspects of human behavior (Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006; Koch & Tsuchiya, 2007; Lamme, 2003) and that goals can direct executive control processes in the absence of consciousness (Dijksterhuis & Aarts, 2010; Hassin, Aarts, Eitam, Custers, & Kleiman, 2009). In line with this view, the control structures in the brain (frontal cortices) that serve goals seem to operate independently from the structures that give rise to conscious awareness (Desmurget et al., 2009; Frith, Blakemore, & Wolpert, 2000). These recent advances in theory and research on consciousness, attention, and control open the possibility that goals that are activated and pursued unconsciously may non-consciously engage executive control processes.

There are now numerous studies indicating that human goal pursuit can emerge outside conscious awareness (for recent reviews, see Bargh et al., 2010; Custers & Aarts, 2010). However, these goal priming effects are often explained in terms of associative networks that do not require executive control (Aarts & Dijksterhuis, 2000; Bargh, 1990; Fishbach, Friedman, & Kruglanski, 2003; Shah, Friedman, & Kruglanski, 2002). Goal pursuit is assumed to become automated over time through repeated selection of the most effective action to produce a desired outcome in the goal-relevant situation. Thus, goals are represented as positive outcomes of specific actions (Custers & Aarts, 2005b; Elsner & Hommel, 2001), and automatic goal pursuit relies on knowledge structures stored in memory with associations between the context, goals and their means (Aarts & Dijksterhuis, 2000; Kruglanski et al., 2002; Sheeran et al., 2005). Through these associations, the action to reach a goal can be immediately activated upon the unconscious instigation of that goal. This process is assumed to be fairly rigid and effortless, and it does not claim mental resources.

A fair number of studies, though, suggest that this "automaticity" view might be too restricted. For instance, it has been shown that unconsciously activated goals maintain activity for more than 5 min (Aarts, Custers, & Marien, 2009; Aarts, Custers, & Veltkamp, 2008; Bargh, Gollwitzer, Lee Chai, Barndollar, & Trötschel, 2001); inhibit competing goals to protect the primed goal from distraction (Aarts, Custers, & Holland, 2007; Papies, Stroebe, & Aarts, 2008; Shah et al., 2002); and promote behavior in novel settings and effort in the face of obstacles, especially when the importance to attain goals is high (Aarts, Gollwitzer, & Hassin, 2004; Custers & Aarts, 2005b; Custers, Maas, Wildenbeest, & Aarts, 2008; Eitam, Hassin, & Schul, 2008; Hassin, Bargh, & Zimerman, 2009). Moreover, situations (e.g., shoes are dirty) that are discrepant with unconsciously activated goals (e.g., looking well-groomed) encourage people to adapt their behavior (e.g., selecting the act of polishing), suggesting a role for monitoring and feedback processes (Custers & Aarts, 2005a, 2007; Moskowitz, Gollwitzer, Wasel, & Schaal, 1999). Taken together, these results paint the picture that unconscious goal pursuit is not only controlled by pre-determined associative networks but also involves executive control processes that require mental resources.

Although suggestive, the previous studies are not conclusive. One issue pertains to the possibility that the reported effects on key aspects of executive control might also be explained in terms of automatic cognitive processes. For instance, research on prospective memory suggests that goals have a special status in memory, the so-called intention superiority effect that maintains representations of goals active over time without involvement of executive control processes (Altmann & Trafton, 2002; Goschke & Kuhl, 1993; cf. Zeigarnik, 1927). A similar account may apply to active maintenance of unconsciously activated goals. Also, the inhibition of interfering goals may occur via a direct inhibitory association between the primed and competing goal in memory (Aarts et al., 2007; Shah et al., 2002).

Furthermore, studies testing goal priming effects on behavior often used tasks that allow the primed goals to be pursued and attained (Fishbach & Ferguson, 2007). In some studies there may be an existing and well-learned association between the goal and response measure. Thus, people may unwittingly imitate the behavior of other people more during social interaction when primed with affiliation goals (Lakin & Chartrand, 2003), or they may work harder on tasks when primed with the goal to earn money (Aarts et al., 2004). Also, people may select a particular action in response to situations that are discrepant with an unconscious goal as part of routines that do not require executive control (Custers & Aarts, 2007). In other words, rather than being the result of executive control processes, the reported effects may be driven by existing associative networks of goals and means.

In other studies, however, the latter issue may not apply. These studies (e.g., Fitzsimons & Bargh, 2003; Hassin, Bargh, & Zimerman, 2009) primed achievement goals and tested effects on tasks that rely on executive functions and have no automatic responses, such as an anagram task or the Wisconsin Card Sorting Test (Heaton, Chelune, Talley, Kay, & Curtis, 1993). Thus, these studies suggest that unconscious goal pursuit is sometimes associated with executive control. However, the applicability principle (Higgins, 1996) would also predict that executive control processes can be recruited in tasks that require them, because the task affords this opportunity. This raises the question of whether the mere priming of goals can lead to the recruitment of executive control. Here, we aim to show this by testing that unconscious goals occupy the executive function by directly engaging its processes in tasks that do not afford people to attain the goal.

Unconscious Goal Activation: Occupying the Executive Function

Until now, there is no clear and compelling empirical evidence that an unconscious goal occupies the executive function for its own attainment without conscious awareness of the goal. Executive control processes are limited in capacity, such that their recruitment incurs costs on other tasks that rely on resources for executive control (Barrouillet, Bernardin, Portrat, Vergauwe, & Camos, 2007; Cocchini, Logie, Della Sala, & Baddeley, 2002). In this view, while unconscious goals are active, executive control processes should be less available for other tasks. Accordingly, executive control performance on these tasks should be impaired after unconscious goal activation.

There are a few studies that provide indirect evidence for this hypothesis. In their research on goal system theory (Kruglanski et al., 2002), Shah and Kruglanski (2002) proposed that priming alternative goals unrelated to current goal pursuit foster a whole range of cognitive and motivational outcomes that detrimentally affect attainment of the focal goal. Consistent with this view, they found that unconscious activation of a task goal only impaired performance on a task involving executive control (solving anagrams) when the task was perceived as unrelated to the primed goal, while performance was unaffected (or even improved) when the task was perceived as related to the goal. While the impairment effects might be due to the recruitment of the executive function by the unconsciously activated goal, they may also have resulted from a drop in motivation for the executive control task. In line with this idea, Shah and Kruglanski (2002) interpreted their effects as "reflecting the waxing and waning of goal focus that results from the subliminal presentation of a facilitating or unrelated alternative goal" (p. 380). Commitment to the executive control task automatically decreased by means of a well-learned inhibitory link between the primed goal and the goal of the executive control task (Shah, Kruglanski, & Friedman, 2003). Accordingly, the nature of the reported effects was dependent on inter-goal relations, and hence they do not demonstrate that unconscious goals by themselves (independent of task goals) occupy the executive function.

More recent work comes closer to the current hypothesis under investigation. In two studies, Masicampo and Baumeister (2011) exposed subjects to consciously visible words (e.g., honest, sincere) to prime a goal construct (e.g., honesty), and they tested effects on unrelated tasks that likely rely on executive control (anagram task, cookie resistance task). Priming had no direct effect on executive control performance. However, executive control was impaired when participants were asked to consciously reflect on the personal unfulfillment of the primed goal. These results have two interesting implications. First, the failure to find impairment effects of priming suggests that executive control was not occupied by an unconscious goal to advance itself or that goal pursuit was not launched in the first place. Second, the fact that the unfulfillment condition was required to impair performance suggests that consciousness might have played a role in modulating the significance of primed goal constructs and subsequent executive control performance. Research indicates that concepts that are primed outside of awareness can enter the conscious mind via several mechanisms, such as construal (Kay & Ross, 2003; Loersch & Payne, 2011), task frustration (Bongers, Dijksterhuis, & Spears, 2010), and attentional cueing (Holland, Hendriks, & Aarts, 2005). In line with this evidence, Masicampo and Baumeister (2011) concluded that "goals that tend to operate outside of awareness may begin to draw on other, more conscious processes when they have been left unfulfilled" (p. 310). Thus, while promising, their findings do not unequivocally show that executive control was recruited by an unconsciously activated goal for its own attainment.

To conclude, research on unconscious goal pursuit is extensive and still growing, and it offers good clues that unconscious goals may engage executive control processes. However, the evidence does not clearly demonstrate that the executive function was occupied while a goal is unconsciously activated. Whereas some findings are still open to an associative-network account of goal priming, other findings may reflect the involvement of executive control as a means or opportunity to reach or express the primed goal. Furthermore, a few studies found impairment effects on executive control tasks unrelated to primed goals, but it remains ambiguous whether these effects represent unconscious goal effects or whether they can be better understood in terms of reduced motivation of the unrelated task or induced awareness of primed goals.

The present research aims to provide novel evidence by testing the notion that unconsciously activated goals occupy the executive function for their own attainment, in the hope to further the understanding and examination of the human capacity to pursue goals in the absence of conscious awareness.

The Present Research

A major assumption underlying the current research is that if unconsciously activated goals occupy executive control processes, then executive control capacity should be less available for other unrelated executive control tasks (Aarts, 2007; Dijksterhuis & Aarts, 2010; Hassin, Aarts, et al., 2009). Accordingly, performance should be impaired on the executive control task as a result of the operation of an unconsciously activated goal.

We report a series of six experiments. In all of them, we first subliminally primed goals and subsequently measured participants' performance on a second goal-unrelated task that (partially) examines executive functions. Subliminal stimulation has been shown to be an effective tool in activating goals unconsciously (Custers & Aarts, 2010) and, thus, offers a compelling case for the hypothesis that unconscious goals occupy executive control for its own attainment.

In the first three experiments we aim to offer basic evidence for our hypothesis by using a memory-probe task that was specifically designed to test executive control and non-executive performance at the same time (Smith & Jonides, 1999; see also D'Esposito, Postle, Jonides, & Smith, 1999; Jonides, Smith, Marshuetz, Koeppe, & Reuter-Lorenz, 1998). As such, this task allows us to distinguish between occupation of the executive function and a more general mechanism of reduced motivation.

In the last three experiments, we aim to push our test one step further by examining whether unconsciously activated goals impair performance on an everyday task that relies on executive control: detection of errors in text (Britton & Glynn, 1987). Performance of detecting text errors in a proofreading task is known to be impaired when executive control is occupied and being taxed (Larigauderie, Gaonac'h, & Lacroix, 1998; Roussey & Piolat, 2008). Accordingly, if unconsciously activated goals indeed occupy executive control, participants should be less capable in detecting the text errors, because they have less executive control left to carefully process the text.

Apart from being able to demonstrate that the obtained effects of unconscious goal activation on executive control are not specific to the memory-probe paradigm, these last three experiments test more specific components of our claim—that is, that conscious goals and unconscious goals are similar in the domains examined here, that this is a general effect that is independent of the relation between the activated goal and the task that measures executive control, and that this effect becomes stronger if the goal is more important.

Experiments 1a and 1b: Unconsciously Activated Goals Occupy the Executive Function

In these experiments, we use the memory-probe task as a measure of the availability of executive resources (Smith & Jonides, 1999). In this memory-probe task, participants see a set of four target letters followed by a probe letter. They have to indicate, as fast as possible, whether the probe matches any of the target letters. If there is a match (positive probe trial), responding is relatively easy, and it seems safe to assume that reaction times (RTs) are mainly dependent on people's general motivation for the task. When there is no match (negative probe trial), performance depends on the previous trial. If the probe matches one of the four letters presented in the previous trial, participants have to overcome their prepotent tendency to answer positively. This inhibitory process is a crucial component of executive control, and neuroimaging research clearly shows that lateral areas in the prefrontal cortex are recruited on negative probe trials requiring inhibitory control (D'Esposito et al., 1999; Jonides et al., 1998; Smith & Jonides, 1999). Performance on this type of negative probe trials thus is a valid indicator of executive control: More impaired performance (compared to the baseline trials) implies less available capacity for executive control.

In Experiment 1a, the goal to socialize was activated outside participants' conscious awareness. Previous research has shown that, among students, the goal to socialize is desirable and can be primed (Aarts et al., 2007; Ferguson, 2008; Sheeran et al., 2005). Experiment 1b served as a conceptual replication in which an idiosyncratic (self-described) goal was activated unconsciously. After the priming manipulation, performance on the memory-probe task was assessed in both experiments. If an unconsciously activated goal indeed occupies executive control processes in order to advance itself, performance should only be impaired on the negative probe trials for which the probe was presented on the previous trial (compared to the negative probe baseline trials, where this was not the case), as responding to these trials requires executive control. However, an unconsciously activated goal is expected to not impair performance on the positive probe trials for which the probe was presented on the previous trial (compared to positive probe baseline trials, where this was not the case), as responding to these trials does not require much executive control (D'Esposito et al., 1999; Jonides et al., 1998).

Method

Participants and design. Forty-seven undergraduates participated in Experiment 1a, and 72 undergraduates participated in Experiment 1b. They received course credits or a small fee in return. In both experiments, participants were randomly assigned to either a no-goal control condition or an unconscious goal condition.

General procedure. On arrival at the laboratory, participants were told that they would take part in research conducted by different research teams and that they had to perform several unrelated tasks on a computer. The computer program assigned participants to conditions randomly and provided the instructions for the tasks. Participants worked individually in a cubicle in which the experiment was presented on a computer with a 100-Hz cathode ray tube screen. After some general instructions and practice with the computer program and upcoming tasks, participants began the experiment. Basically, both experiments consisted of two consecutive tasks: the goal activation task and the memory-probe task. However, in Experiment 1b, participants first completed a goal inventory task to gain information about their self-described goals.

Experiment 1a: Goal activation task. The goal activation task was modeled after previous research on subliminal priming (Aarts et al., 2005; Custers, Aarts, Oikawa, & Elliot, 2009; Veltkamp, Aarts, & Custers, 2009). Participants performed a letter-detection task, in which they were asked to indicate whether a string of letters (e.g., aaaAaa) contained a capital (half of the strings did contain one). Each trial began with a fixation-point (row of asterisks) that appeared on the screen for 500 ms. Next, a premask string of random (upper and lower case) letters was presented for 300 ms. The prime/control word was then presented for 20 ms, immediately followed by a postmask string of random letters (300 ms). Finally, the target string of letters was presented and remained on the screen until a response was made. To activate the socializing goal, participants in the unconscious goal activation condition were exposed to four socializing-related prime words (*socializing*, *partying*, *dancing*, and *celebrating*). Based on earlier work (e.g., Custers & Aarts, 2007; Sheeran et al., 2005), we assume that our participants represent these stimulus words in terms of positive or desired outcomes that are attainable by specific actions. Participants in the control condition were exposed to four (common object) prime words (*light*, *bicycle*, *table*, and *spoon*) that were unrelated to socializing and that people do not likely represent as goals.[1] The inter-trial interval was 1.5 s. In total, there were 40 priming trials that were randomly presented.

To ensure that the socializing goal primes were presented subliminally, that is, that the primes could not be consciously identified as meaningful words (Marcel, 1983), an independent sample of participants ($N = 40$) was subjected to the goal activation task. Specifically, they were given the same letter-detection task; however, this time they indicated for each trial whether a word or a non-word was presented. Half of the trials consisted of the four socializing words, and half of them consisted of random strings of letters. Results revealed that overall accuracy was not different from chance level: 50.6%, $SD = 4.9$, $t < 1$, *ns*. These results show that our goal activation procedure prevented participants from consciously perceiving the socializing primes.

Experiment 1b: Goal inventory and activation task. The first part of Experiment 1b started with the goal inventory task. Accordingly, all participants were asked to carefully consider the goals they had for themselves in the near future and to describe one goal they felt to be very important to attain in the near future. They were asked to type their goal into the computer by using one single word (for a similar procedure, see Danner, Aarts, Papies, & De Vries, 2011; Shah et al., 2002). Most participants (69.4%) typed in a word that was related to academic goals, such as *studying*, *reading*, or *writing*. The remaining participants (30.6%) typed in words that were unrelated to academic goals, such as *dieting* or *cleaning*. After the goal inventory task, participants received several unrelated filler tasks, designed by other research teams in the department. It took participants a long time to complete the tasks (circa 45 min). The filler tasks were given to remove the self-described goal from memory. Next, participants performed a goal activation task that was similar to the one used in Experiment 1a, with one major difference. In the unconscious goal activation condition, the goal prime consisted of the goal word that participants had typed in earlier.

Again, we checked whether the self-described goal primes were presented subliminally. Accordingly, another independent sample of participants ($N = 36$) first nominated a short-term important goal and (after unrelated filler tasks) engaged in the goal activation task. They performed the letter-detection task and indicated for each trial whether a word or a non-word was presented. Half of the trials consisted of the self-described goal word, and half of them consisted of a random string of letters. Results revealed that overall accuracy was not different from chance level: 50.2%, $SD = 4.2$, $t < 1$, *ns*. These results indicate that participants could not consciously see their own goal word prime in our goal activation procedure.

Executive control task. After the goal activation task, participants in both experiments engaged in the memory-probe task in order to measure available executive control capacity. In each trial of this task, participants are presented with a target set of four consonant letters, which are followed by a probe letter after a short delay. Participants' task is to indicate, as quickly and accurately as possible, whether the probe letter has appeared in the target set.

At the beginning of each trial, a fixation point (+) appeared in the center of the screen for 500 ms. Next, a set of four letters appeared in a square around the fixation point for another 500 ms. After an interval of 2,700 ms, the probe appeared in the location of the fixation point. Participants' task was to respond by pressing a "yes" or "no" key within 1,500 ms. After pressing a key, the next trial began. The first four trials were warming-up trials, and the remaining 80 trials were composed of 20 probes of each type (see below), which were presented in random order. The task took about 5–6 min.

There were four within-subject conditions in this task. In the Recent Negative condition, the probe did not match any letter of the most recent target set (and hence required a negative response), but it did match an item from the two target sets that preceded it (e.g., the probe *T* appeared after the set PQRS, which was preceded by the sets GK*T*R and BMN*T*). In the Non-Recent Negative condition, the probe neither matched an item from the most recent set (and hence required a negative response) nor did it match an item from the two sets that preceded it (e.g., the probe *T* appeared after the set PQRS, which was preceded by the sets GKOR and BMNO). This last type of trials thus can be taken as a baseline for the speed of producing a no-response. We refer to the probes in these two conditions as "negative probes." In addition to the negative probe trials, there were positive probe trials that required a yes-response, and to control for recency effects, there was a recent and non-recent condition. In the Recent Positive condition, the probe matched an item from the most recent target set (and thus required a positive response) and the set that preceded it (e.g., the probe *T* appeared after the set PQR*T*, which was preceded by the set GK*T*R). Lastly, in the Non-Recent Positive condition, the probe matched an item from the most recent target set (and thus required a positive response) but not from the set that preceded it (e.g., the probe *T* appeared after the set PQR*T*, which was preceded by the set GKOR).

In this task, available executive control capacity is reflected by a Recency × Probe interaction. Specifically, RTs to recent negative probes are typically longer than RTs to non-recent (baseline) negative probes. No such effect, however, is expected for positive probes.

Results

The main dependent variables are accuracy and the response latencies for correct responses. Both variables were averaged across conditions and were subjected to a 2 (Goal Activation: goal vs. no-goal control) × 2 (Probe: positive vs. negative) × 2 (Recency: recent vs. non-recent) analysis of variance (ANOVA), with the last two factors as within-subjects factors. We first report the results of Experiment 1a, followed by the results of Experiment 1b.

Experiment 1a: Socializing goal.

Response latencies. The analyses yielded a marginally significant main effect of Probe, $F(1, 45) = 3.54$, $p = .07$, $\eta^2 = .07$,

[1] How stimuli are capable of activating goals unconsciously is not specified in the literature (Bargh, 2006). In the present research, we used words in the goal condition that all pertain to positive outcomes (e.g., partying) that can be achieved by performing actions (e.g., by calling a friend) and that had a common denominator (the goal of socializing). The control primes did not refer to a clear outcome of an action (e.g., a spoon, a bicycle). As goals are argued to be represented in terms of desired outcomes of actions (e.g., Custers & Aarts, 2005a; Elsner & Hommel, 2001), it may well be the case that one way to unconsciously activate a goal is to use primes that refer to positive action outcomes. Given that this was not empirically addressed, though, this observation is suggested as a speculation, not as a claim.

and a main effect of Recency, $F(1, 45) = 8.10$, $p = .007$, $\eta^2 = .15$. Replicating the modal findings with this paradigm, a Probe × Recency interaction effect was found, $F(1, 45) = 13.07$, $p = .001$, $\eta^2 = .23$. This interaction was such that responses to recent negative probes were slower than to non-recent (baseline) negative probes, $F(1, 45) = 36.41$, $p = .001$, $\eta^2 = .45$, while no such difference emerged for positive probes, $F < 1$, *ns*. This pattern was qualified by a significant three-way interaction of Goal Activation, Probe, and Recency, $F(1, 45) = 6.10$, $p = .02$, $\eta^2 = .12$.

Turning to the current hypothesis, a reduction in executive control performance may be evidenced in a Recency × Goal Activation interaction for the negative probes. This interaction was indeed significant, $F(1, 45) = 6.54$, $p < .02$, $\eta^2 = .13$. The interaction for the negative probes indicated that responding to the recent (compared to the non-recent, baseline) negative probes was difficult for participants in both the goal and the no-goal control condition. However, this difficulty was larger when the socializing goal was unconsciously activated. Supporting this observation, simple analyses of main effects showed that the difference between recent negative probes versus non-recent baseline negative probes was significant in the no-goal control condition, $F(1, 45) = 6.17$, $p < .02$, $\eta^2 = .12$. However, the difference between recent negative probes versus non-recent baseline negative probes was much stronger and highly significant in the goal activation condition, $F(1, 45) = 36.14$, $p < .001$, $\eta^2 = .45$. Finally, the Recency × Goal Activation interaction for the positive probes was not significant, $F(1, 45) = 1.98$, *ns*, indicating that goal activation only affected the speed of responding to the recent negative probes but not the recent positive probes. The differential effects of goal activation on the positive and negative probes are depicted in Figure 1 (left panel). For the ease of reading, these results are presented in terms of difference scores, which clearly show that the "cost" for negative probes (i.e., RTs to recent negative probes minus RTs to non-recent baseline negative probes) was larger for the goal activation condition (vs. the control condition).

Accuracy. In line with the modal findings with this paradigm, participants made only a few mistakes, as was revealed by the high mean score of accuracy. The analyses yielded a main effect of Probe, $F(1, 45) = 21.50$, $p = .001$, $\eta^2 = .32$, and a main effect of Recency, $F(1, 45) = 7.97$, $p = .007$, $\eta^2 = .15$. Participants were less accurate on the positive probe trials (88.4%) than on the negative probe trials (93.2%), and they were less accurate on the recent probe trials (89.8%) than on the non-recent probe trials (91.9%). No other significant effects emerged.

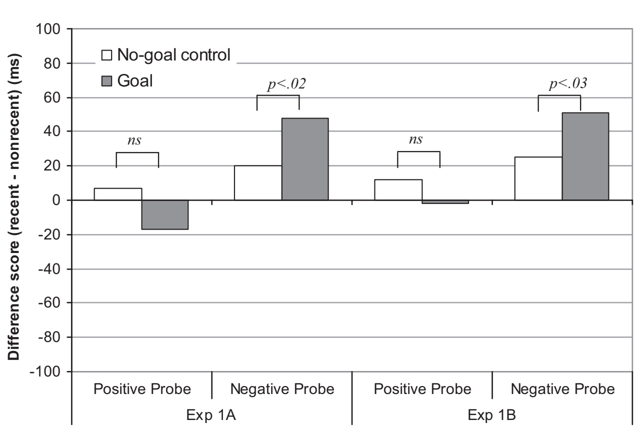

Figure 1. Mean response latencies in Experiments 1a and 1b are presented as difference scores (reaction time [RT] recent − RT non-recent) in milliseconds as a function of Priming and Probe.

Experiment 1b: Self-described goal.

Response latencies. The analyses yielded a main effect of Recency, $F(1, 70) = 28.42$, $p = .001$, $\eta^2 = .29$, and the typical Probe × Recency interaction in this task, $F(1, 70) = 10.61$, $p = .002$, $\eta^2 = .13$. As in Experiment 1a, responses to recent negative probes were slower than to non-recent (baseline) negative probes, $F(1, 70) = 41.56$, $p = .001$, $\eta^2 = .37$, but no such effect emerged for the positive probes, $F < 1$, *ns*. Importantly, the significant three-way interaction of Priming, Probe, and Recency also emerged, $F(1, 70) = 4.10$, $p = .05$, $\eta^2 = .06$.

To examine whether the unconsciously activated self-described goal impaired executive control performance on the memory-probe task, we again tested the 2 (Recency) × 2 (Goal Activation) interaction for the negative probes and positive probes separately. In line with the findings of Experiment 1a, this interaction was present for the negative probes, $F(1, 70) = 5.27$, $p < .03$, $\eta^2 = .07$, but not for the positive probes, $F(1, 70) = 0.95$, *ns*. An examination of the difference scores between recent and non-recent baseline negative probes (see Figure 1, right panel) reveals that responses to recent negative probes were slower than to non-recent baseline negative probes in the control condition. However, these differences were more pronounced for the goal activation condition. Corroborating this notion, simple analyses of main effects showed that the difference between recent negative probes versus non-recent baseline negative probes was significant in the no-goal control condition, $F(1, 70) = 9.13$, $p < .004$, $\eta^2 = .12$. This difference was much stronger and highly significant in the goal condition, $F(1, 70) = 36.20$, $p < .001$, $\eta^2 = .34$.

Accuracy. Accuracy of responses was generally high. Furthermore, there was a main effect of Probe, $F(1, 70) = 13.27$, $p = .001$, $\eta^2 = .16$, and a Probe × Recency interaction, $F(1, 70) = 22.02$, $p = .001$, $\eta^2 = .24$. The interaction indicates that participants were less accurate on recent negative probes (90.9%) than with non-recent negative probes (94.4%), $F(1, 70) = 23.75$, $p = .000$, $\eta^2 = .25$, while the opposite pattern was obtained for positive probes such that participants were more accurate on recent positive probes (90.8%) than with non-recent positive probes (87.4%), $F(1, 70) = 7.33$, $p = .009$, $\eta^2 = .10$. No other effects were significant.

In sum, unconscious goal activation effects on impairment of executive control were manifested on response latencies of recent negative probes, and not on accuracy. Furthermore, results of Experiments 1a and 1b correspond with each other, and they indicate that the overall pattern of findings does not depend on the content of the goal. Moreover, in Experiment 1b, there was no difference between participants who nominated an academic goal and those who nominated another (nonacademic) goal, as was evidenced by the non-significant four-way interaction of Priming, Probe, Recency, and Goal Type on response latencies ($F < 1$).

Discussion

The results of the first two experiments support the hypothesis that unconsciously activating a goal results in impaired performance on the executive control task, and that this impairment was not conditional on the content of the goal. More specifically, subliminal priming of a socializing goal (Experiment 1a) or a self-described goal (Experiment 1b) resulted in a more pronounced difficulty in inhibition of prepotent responses. This was revealed by the significant Recency × Goal Activation interaction for the response latencies on negative probe trials, indicating that it took participants more time to override a prepotent response (yes, there is a match) with a no-response. Importantly, unconscious activation of goals did not alter performance on the positive probe trials, because performance on these trials does not especially rely on executive control. This selective effect on the negative probe trials shows that unconsciously activated goals did not impair general performance on a subsequent task. Unconscious goals only affected inhibitory control performance, which clearly speaks to the notion that unconscious goals occupy executive control processes for their own attainment.

Experiment 2: Ruling out Differences in Task Motivation as Explanation

Although our results provide evidence that unconsciously activated goals occupy the executive function and, hence, impair executive control performance, it might be argued that these results can be explained by differences in general task motivation. That is, participants could have been less willing to spend effort in the memory-probe task when a goal was primed. Previous research indeed suggests that priming alternative goals unrelated to a focal task goal may undermine the motivation and subsequent performance on the task (Shah et al., 2003). Such a decrease in general task motivation and performance would be different from the one we propose. That is, we argue that an unconsciously activated goal occupies executive control for its own attainment and should, in principle, impair performance on an unrelated executive control task independently of the motivation to work on the task.

To rule this out, in Experiment 2 we also manipulated the level of task motivation for the memory-probe task by offering some participants a monetary reward for performance. This enabled us to test the effects of task motivation on the recent probes task and also the interaction between task motivation and unconscious goal activation. More specifically, if unconscious goals impair performance on the recent negative probes by decreasing task motivation, than increasing task motivation should dampen or maybe even eliminate the effect of the unconscious goal. This should be evidenced by a four-way interaction, in such a way that the goal activation impairment effect on recent negative probes is absent or significantly lower in a condition of high task motivation. However, if the effect of unconscious goal activation on executive control performance is independent of task motivation, as we hypothesized, then this interaction should not emerge. In that case, monetary rewards will likely increase general task performance as a result of enhanced effort, thus speeding up responses (and/or improving accuracy) on all trials (Bijleveld, Custers, & Aarts, 2010).

Method

Participants and design. Seventy-eight undergraduates participated in the study receiving course credits or a small fee. They were randomly assigned to the cells of a 2 (Goal Activation: goal vs. no-goal) × 2 (Task motivation: high vs. low) between-subjects design.

Procedure. On arrival at the lab, participants were told that they had to perform several tasks on the computer. Participants were further told that the experiment consisted of several unrelated tasks, designed by different research teams. Participants worked individually in a cubicle, and the computer program provided all the instructions.

Goal activation task. Participants performed the letter-detection task in which the socializing goal was subliminally primed or not (see Experiment 1a). In the unconscious goal condition the prime consisted of the word *socializing,* and in the no-goal control condition, a random letter string was presented as a prime.

Executive control task. This was the memory-probe task.

Manipulation of task motivation. Task motivation was manipulated by using a monetary incentive for performance on the memory-probe task. Participants in the high task motivation condition could win a gift voucher of €20 for their performance on speed and accuracy in the executive control task. More specifically, they learned that the best five participants of the experimental session would win the gift voucher. Participants in the low task motivation condition were not presented with this information. A week after the session, the gift voucher was awarded to the five best performers.

Results

Response latencies. Response latencies for correct responses were averaged across conditions and subjected to a 2 (Goal Activation: goal vs. no-goal control) × 2 (Task Motivation: high vs. low) × 2 (Probe: positive vs. negative) × 2 (Recency: recent vs. non-recent) ANOVA, where the last two factors served as within subjects factors. One participant was removed from the present analyses due to exceptionally high error rates (55%).

There was a main effect of Task Motivation, $F(1, 73) = 7.67$, $p < .01$, $\eta^2 = .10$, showing that participants in the high motivation condition ($M = 621$ ms, $SD = 88$ ms) responded faster than participants in the low motivation condition ($M = 681$ ms, $SD = 102$ ms). Furthermore, replicating the modal results with this paradigm, the analyses yielded a main effect of Recency, $F(1, 73) = 13.62$, $p < .001$, $\eta^2 = .16$, qualified by the Probe × Recency interaction, $F(1, 73) = 40.26$, $p < .001$, $\eta^2 = .36$; responses to recent negative probes were slower than to non-recent baseline negative probes, $F(1, 73) = 81.69$, $p < .001$, $\eta^2 = .52$, but no differences between recent and non-recent positive probes emerged, $F(1, 73) = 1.68$, $p = .20$.

Consistent with the previous two experiments, a significant three-way interaction of Goal Activation, Probe, and Recency emerged, $F(1, 73) = 4.23$, $p = .04$, $\eta^2 = .06$. Importantly, there was no four-way interaction of Goal Activation, Task Motivation, Probe, and Recency $F(1, 73) = 0.59$, $p = .45$, indicating that the pattern of the three-way interaction was not significantly different in the high task motivation group compared to the low task motivation group.

Figure 2 presents the difference scores between recent and non-recent positive and negative probes for the no-goal and goal conditions, collapsed over Task Motivation. An examination of

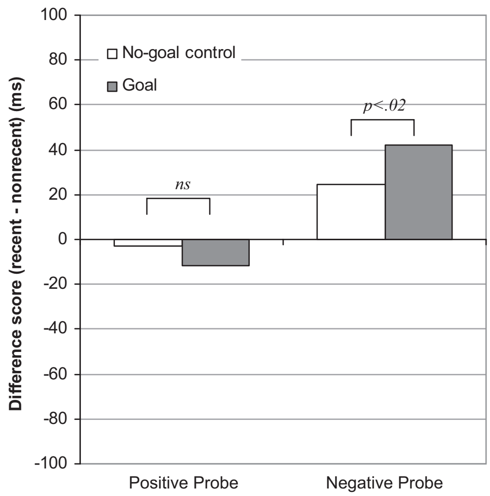

Figure 2. Mean response latencies in Experiment 2 are presented as difference scores (reaction time [RT] recent − RT non-recent) in milliseconds as a function of Priming and Probe, collapsed over Task motivation conditions.

Figure 2 reveals that responses to recent negative probes were slower than to non-recent baseline negative probes in the control condition. These differences were more pronounced for the goal activation condition. Supporting this observation, simple analyses of main effects showed that the difference between recent negative probes versus non-recent baseline negative probes was significant in the no-goal control condition, $F(1, 75) = 20.42$, $p < .001$, $\eta^2 = .21$. However, the difference was much stronger and highly significant in the goal condition, $F(1, 75) = 69.56$, $p < .001$, $\eta^2 = .48$. This interaction between recency and goal activation for the negative probes was significant, $F(1, 73) = 6.19$, $p < .02$, $\eta^2 = .08$. The Recency × Goal activation interaction for the positive probes was not significant, $F(1, 73) = 0.52$, *ns*, again indicating that goal activation only affected the speed of responding to the recent negative probe trials but not the recent positive probe trials.

Accuracy. The accuracy of responses was averaged across conditions and was subjected to ANOVA, according to the design. The analyses did not yield a main effect of Task Motivation, $F(1, 73) = 0.58$, $p = .45$, indicating that the reward manipulation did not affect task performance in terms of accuracy. There was a main effect of Probe, $F(1, 73) = 46.11$, $p < .001$, $\eta^2 = .39$, and a Probe × Recency interaction, $F(1, 73) = 9.06$, $p = .004$, $\eta^2 = .11$. The interaction indicates that participants were less accurate on recent negative probes (93.0%) than with non-recent negative probes (96.0%), $F(1, 73) = 20.51$, $p < .001$, $\eta^2 = .22$, while there was no significant difference between recent positive probes (88.6%) and non-recent positive probes (87.3%), $F(1, 73) = 1.09$, $p = .30$. No other effects were significant.

Discussion

The results of Experiment 2 replicate and extend those of Experiments 1a and 1b. Unconscious activation of a socializing goal impaired performance on negative probe trials that require executive (inhibitory) control. More importantly, although performance on the memory-probe task was improved by the monetary reward manipulation of task motivation, the specific impairment effect on the negative probes by unconscious goals was not eliminated when task motivation was increased. Moreover, task motivation did not specifically affect performance on the recent negative probes, but it speeded up responses to all trials, which is in line with research showing that monetary rewards modulate general performance on tasks that require effort (Bijleveld et al., 2010). These data provide further support to our contention that the reported impairment effect by unconscious goals is unique to executive control and should not be attributed to a decreased motivation to do the task well.

Monetary compensation is generally perceived as one of the most effective manipulations of task motivation. Thus, its failure to obliterate the effects of priming is noteworthy, making it more likely that the null hypothesis really reflects no effect, rather than a simple failure of finding an effect (Frick, 1995). These findings thus provide more conclusive evidence that the executive function was occupied by the unconscious goal during execution of the memory-probe task.

Experiment 3: Comparing Effects of Consciously and Unconsciously Activated Goals

So far, the findings of three experiments indicate that unconsciously activated goals recruit the executive function and, hence, impair performance on a subsequent task that relies on executive control. Importantly, these findings were obtained in a paradigm that allows a fine-grained analysis in the separation of executive control from general performance. In Experiments 3–5, we gave up this high level of precision to extend our findings to a more naturalistic setting in which executive control may be required. More specifically, after participants were primed with an unconscious goal, we asked them to carefully read a short piece of text within a limited amount of time, and we assessed their ability to detect errors. The idea behind this set-up is that when participants' executive control is occupied by an unconscious goal, they are less able to detect the errors, because detecting errors while reading text is known to rely on executive control processes (Britton & Glynn, 1987; Larigauderie et al., 1998; Pilotti, Chodorow, & Thornton, 2004). Based on the results of the first three experiments, we thus tested the idea that performance of detecting errors during reading text should be impaired after participants are primed with a self-described goal.

Experiment 3 also served a second important objective. In order to provide more compelling support for the idea that impaired performance on an executive control task is the result of the recruitment of executive control by a goal, we compared the effects of an unconscious self-described goal with a consciously primed self-described goal. First, recent work suggests that consciously held (unfulfilled) goals can impair executive control performance (Masicampo & Baumeister, 2011). Furthermore, previous research indicates that unconsciously and consciously activated goals affect subsequent goal pursuit in a similar way (Bargh et al., 2010). Based on these similarity findings, we expected that participants' self-described goals impair text error detection performance on the reading task, regardless of whether these goals are activated unconsciously or consciously.

Method

Participants and design. One-hundred-and-two students participated in this study, receiving a small fee or course credit in return. They were randomly assigned to either a no-goal (control) condition, an unconscious goal condition, or a conscious goal condition.

Procedure. On arrival at the lab, participants were told that they had to perform several tasks on the computer. Furthermore, it was told that the experiment consisted of several unrelated tasks designed by different research teams. Participants worked individually in a cubicle, and the computer program provided all the instructions. After some general instructions and practice with the computer program, they started on the first task.

Goal inventory task. The first part of the experiment started with the goal inventory task (see Experiment 1b). Accordingly, all participants were asked to describe a goal they found important to attain in the short run. They were asked to type their goal into the computer using one word. After the goal inventory task, participants received several unrelated filler tasks. A small majority of participants (54.9%) typed in a word that was related to academic goals, such as studying or reading. The remaining participants (45.1%) typed in words that were non-academic goals, such as dieting or doing sports.

Goal activation task. After completing the filler tasks, participants performed the letter-detection task in which the self-described goal was subliminally primed or not (see Experiment 1b). In the unconscious goal condition, the prime consisted of the goal word that the participants had entered earlier. In the no-goal control condition, a string of eight random letters was presented as a prime. The conscious goal condition unfolded in the same manner as the no-goal control condition, until the proofreading task was reached that assessed the dependent variable. Before starting on this task, participants in this condition were reminded of their self-described goal by showing them the word they had typed in earlier, and thus they were encouraged to consciously hold the goal in mind.

Proofreading task. Next, participants performed the proofreading task. First, they were asked to proofread a text that allegedly served as a study on language processing. They were told that a short piece of text would be presented on the screen for 60 s and that they should read the text carefully within the allotted time and answer some questions about it later on. The text described the proposal of a city council to reconstruct parts of the city center. The text consisted of 12 sentences, and the total number of words was 180. There were seven text errors (nearly 4%; cf. Larigauderie et al., 1998; Pilotti et al., 2004, for a similar low percentage of errors). Once participants had proofread the text, they were asked to indicate whether they completely read and understood the text. All participants confirmed. Note, however, that participants were not explicitly instructed to count the errors. They were instructed to carefully read the text, which facilitates the detections of errors, an operation that involves executive control (Larigauderie et al., 1998). Capitalizing on this notion, we expected the reported number of errors to be more accurate (i.e., deviate less from the actual number of errors) when executive control processes are not occupied by the unconscious goal.

Performance of text error detection. After participants completed the reading task, they were asked to indicate the number of text errors they had seen in the text. Participants typed in their answers. As a measure of performance of error detection, for each participant, we calculated the absolute difference between their reported number of errors and the actual number of errors (which was 7). A lower score on this measure represents a more accurate report and thus better performance of error detection.

Conscious awareness of the goal. To check whether participants were aware of the self-described goal during the reading task, they responded to an awareness item. Specifically, after the reading task, they were asked to indicate to which degree they had consciously thought about the self-described goal while performing the task. This item was accompanied by a 9-point response scale that ranged from 1 (*not at all*) to 9 (*very*).

Perceived task importance. To explore whether a potential drop in performance on the reading task may be caused by a decrease in participants' importance to engage in the task because of the other active (self-described) goal (Shah & Kruglanski, 2002), we asked participants to indicate their perceived importance of reading the text carefully. This item was accompanied by a 9-point response scale that ranged from 1 (*not at all*) to 9 (*very*).

Finally, participants were debriefed. Debriefing showed that none of them realized the true nature of the study. Participants indicated no awareness of the relationship between the letter detection task and reading task. One participant expressed strong concerns about concentration during the reading task. Data of this participant were omitted from the analyses.

Results and Discussion

Error detection. Our main dependent variable was error detection (lower scores represent better performance). A one-way ANOVA, with goal activation as the single factor, revealed a significant main effect, $F(2, 98) = 3.80$, $p = .03$, $\eta^2 = .07$. The mean performance for each condition is displayed in Figure 3. As can be seen in this figure, participants performed worse in the unconscious goal and conscious goal activation conditions than in

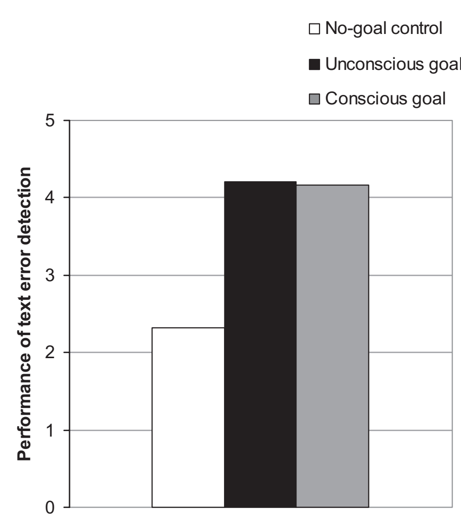

Figure 3. Performance scores of error detection in Experiment 3 as a function of goal condition. Scores closer to zero indicate better performance of error detection.

the no-goal control condition, $F(1, 99) = 5.79$, $p = .02$, $\eta^2 = .06$, and, $F(1, 99) = 5.25$, $p = .02$, $\eta^2 = .05$, respectively. There were no differences between the two goal conditions, $F < 1$.

Effects of goal type. We also tested whether the results depend on the type of self-described goal. According to earlier work on the role of inter-goal relations in goal priming effects, it may be expected that impairment only emerges when the dependent variable task is unrelated to (or competes with) the primed goal (Shah et al., 2003). In the present study, the reading task generally appears to be related to self-described academic goals but not to the self-described non-academic goals, and only this last goal may impair reading performance. To substantiate this notion, an independent sample of students ($N = 42$) performed the reading task and were asked to describe what goal(s) might this task serve. Thirty-four participants (81%) listed descriptions representing an academic goal. However, including the type of self-described goal in the ANOVA testing effects on the error detection in the reading task yielded a non-significant interaction of Goal Activation and Goal Type ($F < 1$), indicating that the unconscious goal activation effects were independent of whether participants listed a non-academic goal or an academic goal.

Conscious awareness of the goal. A one-way ANOVA was performed to check for differences in awareness of the self-described goal during the reading task. This analysis showed a significant difference between conditions, $F(2, 98) = 26.52$, $p < .001$, $\eta^2 = .35$. As expected, participants were more consciously aware of their self-described goal in the conscious goal condition ($M = 6.63$, $SD = 2.20$) than in the no-goal control ($M = 3.42$, $SD = 1.96$) and unconscious goal ($M = 3.26$, $SD = 2.17$) conditions, $F(1, 99) = 31.72$, $p < .001$, $\eta^2 = .24$, and, $F(1, 99) = 38.01$, $p < .001$, $\eta^2 = .28$, respectively. Importantly, the no-goal control and unconscious goal conditions did not differ from each other, $F < 1$. This indicates that our subliminal priming method did not increase awareness of the goal in comparison to not priming the goal at all, thus suggesting that the effects of the unconscious goal are likely to be unconscious.

Perceived task importance. A one-way ANOVA was performed to test the effects of goal activation on the level of importance of the reading task. This analysis showed that participants were equal in their level of subjective importance of reading the text carefully across the three experimental conditions, $F < 1$, *ns*.

In sum, results of Experiment 3 show that conscious and unconscious goal activation decreased the ability to detect text errors in a subsequent reading task. These findings indicate that both conscious and unconscious goals recruit executive control processes, thus leaving less room for participants to rely on these processes in other tasks that require executive control for optimal performance. Recent work already suggested that (unfulfilled) conscious goals impair performance on tasks relying on executive control, and these effects could not be attributed to conscious reflection of distraction during the task (Masicampo & Baumeister, 2011). Here, we demonstrate that even when these goals remain unconscious via subliminal priming, these goals seem to hijack executive control for its own attainment. Furthermore, we did not find evidence that these effects are conditional on inter-goal relations (cf. Shah et al., 2003). While participants generally represented the reading task in terms of academic goals, self-described non-academic and academic goals impaired performance on the reading task to the same extent.

Experiment 4: Ruling out Perceived Relatedness Between Goals as Explanation

Experiment 4 served two goals. First, we aimed to replicate the effect of unconscious goal activation on executive control performance assessed by the reading task. A second goal was to further explore the basic nature of how unconscious goals hijack executive functions by demonstrating empirically that the effects are independent of inter-goal relations. Whereas the findings of Experiment 3 are suggestive and promising in this regard, they are based on a null effect, and we hence seek a stronger replication of this null effect. Here, we tried to maximize the likelihood for the goals to be related and actually measured inter-goal relatedness. More compelling evidence thus would be provided if we could show that participants' perceived relatedness of the primed goal and the reading task does not moderate the effects (see for such moderation, Shah & Kruglanski, 2002). Therefore, in Experiment 4, we either unconsciously activated an academic goal in participants or not, and we added a measure of perceived relatedness of the academic goal and the reading task. Exploiting individual differences in perceived relatedness of the academic goal and the goal of the reading task, we thus could test whether or not unconscious goal effects on executive control performance are conditional on perceived inter-goal relations.

Method

Participants and design. Eighty-four undergraduates participated in the study, receiving a small fee or course credit in return. They were randomly assigned to a no-goal (control) condition or an unconscious academic goal condition.

Procedure. On arrival at the lab, participants were told that they had to perform several tasks designed by different research teams. To check whether participants had an academic goal at the time of participation, they first listed academic goal activities they wanted to achieve within a next few days. They also indicated to what extent the word "studying" (the prime word in the goal activation task) represented a goal they actually wanted to attain. One participant reported that the goal was not appropriate. This participant was excluded from our final sample. After a few filler tasks, the remaining 83 participants engaged in two consecutive tasks: the goal activation task and the reading task. Participants worked individually in a cubicle. The computer program provided all the instructions.

Goal activation task. The goal activation task was similar to the one used in the previous experiments. Half of the participants were primed with the academic goal by subliminally presenting the word "studying." In the no-goal control condition, a random letter string was presented as a prime.

Proofreading task. The goal activation task was followed by the reading task.

Perceived inter-goal relation. Next, to measure perceptions of inter-goal relation, we took the measure implemented by Shah and Kruglanski (2002; Studies 1 and 2). Specifically, participants were asked how related is the academic goal to the reading task goal, and they provided answers on a 9-point scale ranging from *not at all* (1) to *very strongly* (9). High scores reflect perceived relatedness of the academic goal and the reading task, whereas low scores indicate that they are perceived to be unrelated.

Results and Discussion

The performance measure of error detection was subjected to the general linear model, with goal activation (no-goal vs. goal) as a between-subjects variable and perceived inter-goal relatedness as a (between-subjects) continuous variable. This analysis revealed a significant main effect for goal activation, $F(1, 80) = 4.30$, $p = .04$, $\eta^2 = .05$; performance was impaired in the goal condition ($M = 3.95$, $SD = 1.76$) compared to the no-goal condition ($M = 3.19$, $SD = 1.58$). However, neither a main effect for perceived inter-goal relatedness, $F(1, 80) = 1.19$, $p = .28$, nor a significant interaction with goal activation occurred, $F(1, 80) = 0.59$, $p = .45$.

The results of Experiment 4 replicate the previous findings by showing that performance of text error detection is impaired by an unconsciously activated academic goal. Furthermore, these effects were not moderated by the perceived relatedness of the primed goal and the reading task. Even though this is a null effect of perceived inter-goal relation, it is in line with the results of Experiment 3 and suggests that unconsciously activated goals engage executive control processes for their own attainment and do not depend on their relation with the goal of the task to occupy the executive function.

Experiment 5: The Moderating Role of Goal Importance

Thus far we have provided strong evidence for the notion that unconscious goals hijack the executive function. However, because of the limited capacity of the executive function, effective goal pursuit does not allow control to be seized by any goal, even though the goal is activated unconsciously. Only goals that are important or have a strong current incentive value to the person are likely to occupy executive control processes for their own attainment (Aarts, 2007; Custers & Aarts, 2010). Accordingly, unconsciously activated goals that are more important should cause people to perform worse on a subsequent unrelated task that requires executive control.

To substantiate the idea that unconscious goal pursuit involves recruitment of executive control, in our final experiment we tested the moderating role of goal importance in the impairment effect. For this purpose, a socializing goal was activated unconsciously. Earlier research has shown that the socializing goal is generally perceived as important but that student participants vary in their perceived importance to attain the goal (Custers & Aarts, 2007; Sheeran et al., 2005). This individual variation in importance of the socializing goal allowed us to test modulation. We predicted that the unconscious activation of the goal to socialize impairs performance but that the impairment is more pronounced when the goal is valued and important to attain.

Method

Participants and design. Sixty-seven undergraduates participated in the study, receiving a small fee or course credit in return. They were randomly assigned to a no-goal (control) condition or to a goal to socialize condition.

Procedure. Like in the previous experiments, participants worked individually in a cubicle on two consecutive tasks: the goal activation task and the reading task. The experiment was followed by an unrelated study to measure goal motivation strength.

Goal activation task. The goal activation task was similar to the one used in Experiment 1a. The goal to socialize was primed by using four words associated with the goal. In the no-goal condition, these four words were replaced by four positive words unrelated to socializing (*beach*, *home*, *summer*, and *smile*). In this study, these positive words were selected to control for possible affective valence effects due to the positivity of the goal. Furthermore, previous work showed that these words do not modulate thoughts about performance (Aarts, Custers, & Veltkamp, 2008; Custers & Aarts, 2005b).

Proofreading task. Next, participants performed the reading task.

Perceived task importance. Participants indicated on a scale ranging from 1 (*not at all*) to 9 (*very*) the importance of reading the text carefully.

Consciously experienced effort. Also, as a check on participants' conscious experiences about the effort they exerted in the reading task, they indicated on a scale ranging from 1 (*not at all*) to 9 (*very*) how much they felt the reading task required effort to perform well.

Conscious awareness of the goal. After the reading task, participants were asked to indicate the extent to which they had consciously thought about the goal of going out and seeing friends while performing the reading task. This item was accompanied by a 9-point response scale that ranged from 1 (*not at all*) to 9 (*very*).

Finally, participants were thoroughly debriefed. The debriefing indicated that none of the participants realized the true nature of the study. Participants indicated no awareness of the relationship between the different tasks.

Measurement of goal importance. After the experiment, participants engaged in an unrelated study, which took about 30 min. At the end of this study, a short questionnaire was administered in which participants had to respond to various items dealing with all kinds of mundane activities. The instructions further stressed the importance of providing honest answers and that all answers would be treated confidentially. Among these items, two questions measured the subjective importance to pursue the socializing goal. Specifically, participants indicated on a scale ranging from 1 (*not at all*) to 9 (*very*) how important the goal of socializing was to them, and how much they wanted to achieve the goal of socializing (see also, Custers & Aarts, 2005b). These two items were combined into an index of goal importance ($r = .41$, $p = .001$). Because this measurement procedure triggers thoughts about the goal of socializing in all participants, we decided to administer the measure after the experimental session, that is, about 30 min after the measurement of the dependent variable (see Bargh & Chartrand, 2000, on the subject of unwanted effects of priming). An ANOVA showed that the level of goal importance was not affected by the goal activation manipulation, $F(1, 65) = 1.67$, *ns*.

Results and Discussion

Performance of text error detection. Error detections were subjected to the general linear model, with goal activation (no-goal vs. goal) as a between-subjects variable and goal importance level as a (between-subjects) continuous variable. This analysis revealed significant main effects for goal activation, $F(1, 63) = 4.68$, $p = .03$, $\eta^2 = .07$, and for goal importance level, $F(1, 63) = 7.63$, $p =$

.008, $\eta^2 = .11$. However, these main effects were qualified by the significant interaction between goal activation and goal importance level, $F(1, 63) = 6.88$, $p = .01$, $\eta^2 = .10$.

In order to examine this interaction and to test our specific hypothesis, the effect of unconscious goal activation on performance of error detection was estimated for participants with a low goal importance level (one standard deviation below the mean of the goal importance measure) and for participants with a high goal importance level (one standard deviation above the mean of the goal importance measure) separately (see Aiken & West, 1991). Figure 4 presents the mean performance scores of error detection for each cell in this design. These analyses showed that participants with a high goal importance level were less accurate in detecting errors when the goal to socialize was activated, compared to when the goal was not activated, $F(1, 63) = 11.04$, $p = .001$. Goal activation did not influence accuracy of detecting errors for participants who had a low level of goal importance, $F < 1$.

Perceived task importance. There were no main effects on the perceived importance of reading the text carefully. Also, the interaction between goal activation and goal importance level was not significant (all Fs < 1). This finding thus indicates that the goal activation manipulation did not render the task to read the text carefully less important.

Consciously experienced effort. Using the experienced effort measurement as a dependent variable revealed no main effects or interaction effect (all Fs < 1.23). Thus, whereas the unconscious activation of the goal to socialize occupies the executive function, it seems that in the present experiment our participants were not aware of its interfering effect.

Conscious awareness of the goal. The general linear model was used to check for differences in awareness of the socializing goal during the reading task as a function of goal activation and goal importance level. This analysis showed no main effects on the goal awareness measure. Also, the interaction between goal activation and goal importance level was not significant (all Fs $<$ 1). This finding thus indicates that the goal activation manipulation did not cause the goal to gain access to conscious awareness.

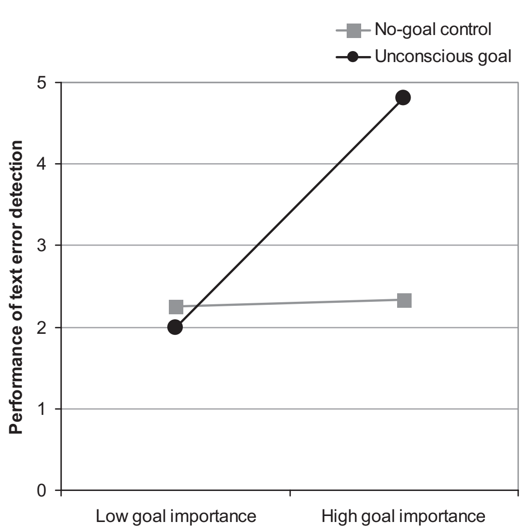

Figure 4. Performance scores of error detection in Experiment 5 as a function of goal condition and goal importance level. Scores closer to zero indicate better performance of error detection.

In sum, results of Experiment 5 showed that performance of text error detection is modulated by the level of importance of the socializing goal. Only unconsciously activated goals that are strongly valued occupied executive control processes that were actually necessary for the detection of text errors. This is an additional key finding for the notion that unconscious goals recruit executive control processes, as only goals that are important should hijack the executive function for its own attainment (Aarts, 2007).

General Discussion

We tested the hypothesis that unconsciously activated goals occupy executive control for their own attainment. For this purpose, we subliminally primed several goals (i.e., self-described, socializing, or academic goals). These primed goals were expected to engage executive control and therefore render these resources less available for other tasks requiring executive control. Accordingly, performance should be impaired on an unrelated executive control task. Findings across six experiments supported this hypothesis. Furthermore, we demonstrated that goals impaired executive control performance on unrelated tasks regardless of the source of activation (conscious vs. unconscious), and that these effects mainly occurred when the goal was important and valuable. Importantly, the impairment effects resulting from the unconsciously activated goal were not attributable to a decrease in general motivation for the task assessing the executive control performance. In addition, the effects were independent of perceived relatedness between the unconscious goal and the task goal. Taken together, then, the present research strongly suggests that unconscious goals can occupy executive control processes in order to advance themselves.

In general, our findings concur with contemporary perspectives that consider unconscious goal pursuit to serve adaptive functions that rely on executive control (Bargh et al., 2010; Hassin, Aarts, et al., 2009). However, whereas most of the available data on unconscious goal activation effects suggest that unconscious goal pursuit is associated with executive control, the evidence is open to accounts that do not speak to the recruitment of an executive function or do not conclusively demonstrate that an unconsciously activated goal recruits executive control in its own service. These alternative interpretations are largely ruled out in the present research by taking a different approach in demonstrating that subliminally activated goals occupy executive control processes and thus impair performance on a goal-unrelated task that requires executive control. Thus, our findings extend earlier work on unconscious goal pursuit by providing more conclusive evidence that an unconscious goal occupies executive control for its own attainment.

Importantly, the observation that unconsciously activated goals impaired performance to a greater extent when the goal was more important and valuable (Experiment 5) suggests that the executive function is mainly hijacked by goals that matter and have rewarding properties (Chiew & Braver, 2011). These effects are assumed to originate from a subcortical reward network that assesses the value of a goal (Phillips, Walton, & Jhou, 2007; Salamone, Correa, Farrar, Nunes, & Pardo, 2009) and projects to prefrontal cortical areas that support executive control processes (Wallis & Kennerley, 2010). In line with this notion, it has been shown that increasing the value of goals by attaching positive affective tags to goal representations not only increases effort in action (Aarts, Custers, & Marien, 2008) but more specifically engages the executive function by rendering goal pursuit more flexible (Marien, Aarts, & Custers, 2012). Our research program thus extends and integrates current inquiries into unconscious goal pursuit (Custers & Aarts, 2010) with modern views on the goal-directed nature of executive control and the possibility that such control occurs in the absence of conscious awareness (Aston-Jones & Cohen, 2005; Hassin, 2005; Suhler & Churchland, 2009).

The finding that unconscious goals affect executive control on other tasks may have important implications for our understanding of human performance. First, whereas the present data were collected under highly controlled circumstances, it is clear that unconsciously activated goals may impede human performance in several ways. Earlier work already demonstrated that goal priming may hinder people from ongoing action control and execution (Schooler, Ohlsson, & Brooks, 1993; Verbruggen & Logan, 2009), likely because the primed goals automatically interfere with the stream of information processing and responding relevant for the task at hand. In addition, other research suggests that unconscious goals may compete with and impair performance of a focal task goal as a result of perceived relatedness of the two goals (Fishbach et al., 2003; Papies et al., 2008; Shah & Kruglanski, 2002), and these effects are explained in terms of a general decrease in cognitive and motivational resources. The exact nature of the process underlying these inter-goal relation effects may require further delineation. However, it seems that these effects typically show up when the relation between the goals is strong (e.g., hedonic eating vs. dieting) or the goals are rendered salient (e.g., by instructing participants that the two goals require attention in a future task), and hence people are encouraged to reflect on both goals and their interrelation (Shah & Kruglanski, 2002, 2003).

The present findings demonstrate another important effect of unconscious goals, one that seizes executive control processes for its own attainment. At times, this unconscious occupation of executive control may be efficient in producing adaptive cognition and behavior without bothering consciousness with the content and process of goal pursuit. However, our findings suggest that it can also cause people to perform worse on other executive control tasks. In the present research, we showed that such detrimental effects crucially affect the ability to inhibit prepotent responses and detecting errors during reading, but it is likely that the unconscious activation and operation of goals affect various aspects of social life that rely on executive control, such as thought suppression (Wegner, 1994), emotion regulation (Gross, 1998), and habit intrusion prevention (Reason, 1990). In other words, the unconscious occupation of the executive function upon the activation of a goal may have a much more profound influence on human behavior than the present data suggest.

Revisiting the Recruitment of Executive Control by Unconscious Goals

The present findings indicate that unconsciously activated goals occupy executive control and seize part of this control function for their own pursuit. However, as far as our data can tell, the recruitment of executive control is not accompanied by conscious awareness of the goal or other experiences pertaining to the operation of the goal, such as perceived effort. The fact that unconscious goals recruit executive control is in line with the general notion that control of behavior rests with the autonomous operation of the goal once it is activated (Bargh & Huang, 2009). Specifically, given the ubiquitous presence of noise in all physiological systems, and the inherently dynamic nature of the mental and physical world, the brain seems to be attuned to immediately access executive control that renders cognition and action both stable and adaptive over time (Lau & Rosenthal, 2011). Therefore, the recruitment of executive control starts upon the activation of goals, and information is being processed that is relevant to attain the active goal. An important feature that determines the strength of this recruitment is the value of the goal. Consciously held goals are more likely to recruit executive control and to mobilize effort when the goal is valuable (Wright & Brehm, 1989). The present research indicates that this is not different for unconscious goals (see also Custers & Aarts, 2005b). Access to and taxing the executive function is thus mainly obtained by those goals that have high value for the individual at the moment of activation.

Furthermore, the finding that unconscious goals recruit executive control sheds new light on the role of consciousness in human behavior. There is quite some research showing that consciously set goals (vs. no goal at all) facilitate human functioning in several ways (e.g., Baddeley, 1993; Baumeister, Mascipamco, & Vohs, 2011; Locke & Latham, 2002; Metcalfe & Mischel, 1999), and these data portray the general picture that consciousness plays a crucial role in the goal-directed nature of executive control and behavior. Although tempting, this conclusion may be wrong or at least premature, as most studies lack the proper controls to exclude the possibility that the effects may also occur when the goal is activated unconsciously (Custers & Aarts, 2010; Lau, 2009). In line with this notion, the present research suggests that both conscious and unconscious goals occupy the executive function once that goal is activated in people's minds. The present analysis, then, suggests that consciousness is not the only key to the recruitment of executive control. This idea is in line with current views that goals control attention and action in the absence of conscious awareness (Dijksterhuis & Aarts, 2010) and that consciousness and attention are distinct aspects of human behavior (Dehaene et al., 2006; Koch & Tsuchiya, 2007; Lamme, 2003).

Our finding that consciously and unconsciously activated goals occupy executive control raises the question whether conscious and unconscious goals rely on the same functional architecture of information processing in which the same cognitive functions or hardware are recruited and shared to pursue goals. Although we are currently not in the position to offer a firm answer, we wish to stress two important issues here. First, while contemporary social cognition research often assumes that unconscious processes are automatic and effortless and, hence, do not use mental resources (for a discussion, see Moors & De Houwer, 2006), this assumption may not hold for unconscious goal pursuit (see Hassin, Aarts, et al., 2009). The pursuit of unconsciously activated goals requires mental resources and is effortful, and it may represent a class of mental processes in which lack of awareness and effort do not go hand in hand (Aarts, Custers, & Veltkamp, 2008; Kleiman & Hassin, 2011; cf. Naccache et al., 2005). Second, it seems likely that unconscious and conscious goals both operate on a platform that usurps mental resources. However, how much this platform shows overlap between unconscious and conscious goals, and whether the amount of resources to work on this platform differs, are key questions that could be more systematically studied in future research to advance the understanding and examination of the human capacity to pursue goals.

Concluding Remarks

Goals play a vital role in controlling human behavior to meet the dynamic qualities of the brain and environment. Our findings indicate that the executive function, responsible for the stable and adaptive regulation of behavior, is hijacked upon the activation of a goal without an act of conscious will. These findings are novel and important, and they suggest that executive control processes are hijacked by goals in order to advance themselves without postulating an inner agent that consciously accesses and directs these control processes. In the search for the human mind and the mental faculties that make human behavior goal-directed, then, the present research may offer new directions in studying how people pursue goals unconsciously and how conscious processes evolve from, and build on, unconscious processes in promoting effective goal pursuit.

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