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Complete unconscious control: Using (in)action primes to demonstrate completely unconscious activation of inhibitory control mechanisms

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ABSTRACT

Although robust evidence indicates that action initiation can occur unconsciously and unintentionally, the literature on action inhibition suggests that inhibition requires both conscious thought and intentionality. In prior research demonstrating automatic inhibition in response to unconsciously processed stimuli, the unconscious stimuli had previously been consciously associated with an inhibitory response within the context of the experiment, and participants had consciously formed a goal to activate inhibition processes when presented with the stimuli (because task instructions required participants to engage in inhibition when the stimuli occurred). Therefore, prior work suggests that some amount of conscious thought and intentionality are required for inhibitory control. In the present research, we recorded event-related potentials during two go/no-go experiments in which participants were subliminally primed with general action/inaction concepts that had never been consciously associated with task-specific responses. We provide the first demonstration that inhibitory control processes can be modulated completely unconsciously and unintentionally.

1. Introduction

Are you in control of your own behavior? A large body of evidence suggests that actions can be initiated unconsciously (Libet, 1985) and unintentionally (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trotschel, 2001), which calls into question the concept of free will and the plausibility of complete conscious control over behavior (cf., Newell & Shanks, in press). However, behavioral control is more than mere action initiation – many critical aspects of behavioral control involve inhibiting (rather than executing) actions. Weight loss, smoking cessation, emotion regulation, and saving money all involve the use of inhibitory control over actions that would otherwise occur (i.e., eating, smoking, emoting, and spending, respectively). According to several influential theories, nonconscious behaviors are relatively inflexible and primarily involve the reproduction of well-learned associations (Bargh, 1990; Kruglanski et al., 2002). Thus, an over-eater's automatic reaction to perceiving food is the desire to eat, a smoker's automatic reaction to perceiving a cigarette is the desire to smoke, and so forth. An important question, then, is whether conscious thought is necessary to engage inhibitory control processes that can override actions when they are initiated, or whether inhibitory processes can also be initiated unconsciously and unintentionally.

Recently, a number of studies have demonstrated that subliminal stimuli can unconsciously activate inhibition processes. However, the stimuli in these studies unconsciously activate inhibitory processes only *after* the stimuli have already been consciously associated with task-spe-

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cific inhibitory responses (D'Ostilio and Garraux, 2012; Hughes, Velmans, & de Fockert, 2009; Praamstra & Seiss, 2005; Van Gaal, Ridderinkhof, Fahrenfort, Scholte, & Lamme, 2008). For example, participants who consciously form implementation intentions to inhibit fear-responses to frightening stimuli (e.g., "When I see blood, I will remain calm") automatically inhibit their emotions to subsequent fear-relevant stimuli, whereas participants who merely form goals to remain calm (e.g., "I will remain calm") but do not form stimulus-inhibition associations do not (Gallo, Keil, McCulloch, Rockstroh, & Gollwitzer, 2009). As a result, the literature on unconscious engagement of inhibition suggests that (a) consciousness is in fact required for inhibitory control (i.e., during pre-inhibition tasks or instructions in which target-stimuli are consciously associated with an inhibition response within the context of the task) and (b) willful intent is also required (i.e., participants form a goal/desire to modulate inhibition processes in response to target-stimuli as part of the task procedure).

Of relevance, individuals are frequently motivated to pursue general activity or inactivity without concern for the specific behaviors pursued or foregone (Albarracin, Hepler, & Tannenbaum, 2011; Albarracin et al., 2008). Consequently, exposing individuals to stimuli associated with the general concept of inaction (action) has been shown to increase (decrease) behavioral inhibition in diverse tasks even though these stimuli were never associated with task-specific responses (Hepler et al., 2012a,b). These behavioral inhibition results would seem to support the conclusion that inhibitory control can be activated unconsciously and unintentionally, without prior conscious input. Although behavioral inhibition can result from modulation of brain-based inhibitory control processes, it can also result from modulation of motor control processes (D'Ostilio and Garraux, 2012). That is, individuals may not-act because they inhibit an action that would have otherwise occurred or because they never begin to execute the action in the first place (i.e., an inhibition of an initiated action versus a lack of action initiation). Thus, demonstrating behavioral inhibition via an absence of action is not the same as demonstrating engagement of inhibitory control processes because it is possible that the absence of action represents a failure to initiate the action rather than an inhibition of the action. Fortunately, an event-related potential (ERP) component called the P3 can reflect engagement of brain-level inhibitory control processes that may not be observable at the level of behavior. Specifically, when participants successfully inhibit a behavior (e.g., a "no-go" response during a go/no-go task), larger P3 amplitude over frontal-central-parietal brain sites approximately 300–550 ms after the onset of a stimulus indicates greater engagement of inhibitory control processes (Smith, Johnstone, & Barry, 2007).

Therefore, to determine whether inhibitory control processes can be unconsciously and unintentionally engaged by stimuli that have never been consciously associated with task-specific behavioral responses, we conducted two experiments in which participants were subliminally primed with general action/inaction concepts during a go/no-go task, and we analyzed P3 amplitude on no-go (inhibition-related) trials as a function of prime to assess engagement of inhibitory control processes. If P3 amplitude is modulated in response to these stimuli, it would be a critical discovery because previous research has only demonstrated unconscious inhibitory control *after* conscious thought has been used to (a) form stimulus-inhibition associations and (b) form intentions to execute those associations. In contrast, we seek to demonstrate that engagement of inhibitory control processes can occur without using conscious thought to associate stimuli with inhibitory responses or to form intentions to modulate inhibitory control.

2. Experiment 1

2.1. Method

2.1.1. Participants

Twenty participants were recruited via an online ad for research participants. Participants were paid a minimum of $10 and could earn up to $30 by exceeding target performance standards provided during the task. The age of participants ranged from 19 to 28 ($M = 21.2$ years, $SD = 2.5$). Thirty percent of respondents were female. The race/ethnicity of the sample was 50% Asian, 45% Caucasian/White, and 5% Black/African-American. All participants were native English speakers, had normal or corrected-to-normal vision, were right-handed, were not currently taking any psychoactive medications, and had refrained from caffeine and tobacco use for at least 1 h prior to the experiment.

2.1.2. Procedure

Participants completed a go/no-go task consisting of one calibration block and two experimental blocks. Each block contained 300 trials, half of which were go trials and half of which were no-go trials, presented in random order. Each trial consisted of the following: a pre-mask of &&&&&& (16.7 ms), a subliminal prime (33.4 ms), a post-mask of &&&&&& (50.1 ms), a target (variable time, see below), and a blank inter-trial interval (650–850 ms, randomly jittered). The targets were the letters X and Y, and the participants' task was to respond by pressing a button on a response box with their right index finger every time they saw an X (a go trial), but not to respond when they saw a Y (a no-go trial). The go target was always X, and the no-go target was always Y. Responses were only recorded if they occurred while a target was on screen. For the present purposes, we analyzed correct rejection trials – i.e., trials on which a Y was presented and participants correctly withheld a response. We focused exclusively on these trials because the P3 ERP response indicates engagement of inhibitory control mechanisms when participants are engaged in inhibitory control behaviors (i.e., when they are correctly not-responding to a no-go stimulus), but the P3 does not necessarily indicate these same processes under other conditions, such as when participants execute a motor response during a go trial (Smith et al., 2007).

2.1.3. Subliminal primes

The pre-mask, prime, and post-mask that occurred during each trial subjectively appeared to be a single, brief