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Unconscious manipulation of free choice by novel primes

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ABSTRACT

The extent to which non-conscious perception can influence behaviour has been a topic of considerable controversy in psychology for decades. Although a challenging task, convincing empirical demonstrations have emerged suggesting that non-consciously perceived 'prime' stimuli can influence motor responses to subsequent targets. Interestingly, recent studies have shown that the influence of masked primes is not restricted to target-elicited responses, but can also bias free-choices between alternative behaviours. The present experiment extends these findings by showing that free-choices could also be biased by novel primes that never appeared as targets and therefore could not trigger acquired stimulus–response (S–R) mappings. This new evidence suggests that free-choice behaviour can be influenced by non-consciously triggered *semantic* representations. Furthermore, the results reported here support accounts of masked priming that posit an automatic semantic categorisation of non-consciously perceived visual stimuli.

1. Introduction

The masked priming paradigm has been widely used to demonstrate that responses to visible targets are facilitated when targets are preceded by masked, response–congruent primes (Damian, 2001; Dehaene et al., 1998; Dell'Acqua & Grainger, 1999; Klotz & Neumann, 1999; Kunde, Kiesel, & Hoffmann, 2003; Neumann & Klotz, 1994). An important implication is that non-consciously presented stimuli can influence target-elicited response production. Yet recent findings suggest that the influence of non-consciously perceived information is not restricted to target-elicited responses, but also impacts response selection from scratch. For example, when participants are allowed to freely choose which of two button-press responses they want to make, they are more likely to choose the response that is congruent with a masked prime. The implication is that *free* choices among response alternatives are subject to non-consciously deployed cognitive processes. At present, the boundary conditions on the non-conscious manipulation of free choices remain unknown. The present experiment aims to explore these boundary conditions by determining whether free choice behaviour can be influenced by non-consciously triggered *semantic* representations.

1.1. Free-choice priming

In a typical free-choice priming paradigm, participants are asked to respond to an imperative stimulus such as a left or right-pointing arrow by making a left or right button-press response. Randomly interspersed amongst these 'forced-choice' trials are 'free-choice' trials, where participants are presented with a different visible stimulus (e.g., a circle) that requires them to freely choose which button-press response (left or right) they want to make. Crucially, all visible stimuli are

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preceded by masked left/right arrow primes. The common finding is that during free-choice trials participants prefer the response alternative that is congruent with the subliminal prime (e.g., a left free-choice response following a left arrow prime), suggesting that seemingly 'free' choices are in fact biased by information that could not be consciously discriminated (Bodner & Mulji, 2010; Kiesel et al., 2006; Mattler & Palmer, 2012; Parkinson & Haggard, 2014; Schlaghecken & Eimer, 2004).

Until now, free-choice priming has been found under restricted experimental situations. For example, an important precondition of free-choice priming is the immediate context in which free-choice trials appear. Specifically, masked primes bias free-choice responses only in experimental blocks where free-choice and forced-choice trials are mixed (Klapp & Haas, 2005; Schlaghecken & Eimer, 2004). Only in such situations do prime stimuli share critical features with the imperative stimuli in the current task, allowing a specific stimulus–response mapping to be imposed on the primes and ultimately facilitating their influence on free-choice performance. In a similar vein, Bodner and Mulji (2010) recently showed that the proportion of forced-choice trials with congruent primes also modulated free-choice priming. In their study, prime-congruent responses to free-choice targets were preferred only in experimental conditions where the proportion of forced-choice trials with congruent primes was .8 rather than .2. Together these results suggest that free-choice priming depends on the strength of the association between each prime and its response (Klapp, 2007).

On the basis of the existing evidence, one might assume that free-choice priming depends on the ability of masked primes to activate a specific action trigger based on their perceptual similarity to visible forced-choice targets. Yet several reports have revealed that in forced-choice scenarios, subliminal primes are automatically processed up to a *semantic* level. For example, Naccache and Dehaene (2001) demonstrated that prime stimuli that never actually appeared as targets could nevertheless influence responses to forthcoming targets. Participants in their study classified the target numbers 1, 4, 6 and 9 as less than or greater than 5. Masked primes were either identical to the targets, or they simply fell on the same side of 5 and thus belonged to the same semantic category (i.e., the numbers 2, 3, 7 and 8). This produced two prime categories: repeat primes (which appeared as targets) and novel primes (which did not). Although no specific stimulus–response association was formed for novel primes, semantic processing/categorisation could still proceed. Non-consciously perceived, novel primes were found to facilitate responses to subsequent targets belonging to the same semantic category. These intriguing findings indicate that semantic coding, categorisation according to arbitrary instructions, and response selection can all proceed without conscious awareness.

Free-choice priming has thus far been found only in situations where prime stimuli also appeared as targets (Bodner & Muji, 2010; Parkinson & Haggard, 2014; Kiesel et al., 2006; Mattler & Palmer, 2012; Schlaghecken & Eimer, 2004). The present experiment will employ a modified version of Naccache and Dehaene's (2001) number magnitude judgement task to determine whether subliminal primes that are semantically related to, but physically distinct from visible targets can bias free-choice performance.

2. Materials and methods

2.1. Participants

Nineteen students of Australian Catholic University, aged between 18 and 35 years, participated in exchange for course credit or for pay. Four participants were male. All reported having normal or corrected-to-normal vision, and were naïve as to the purpose of the experiment. All participants gave their informed consent prior to their inclusion in this study, which was approved by the Human Research Ethics Committee of Australian Catholic University.

2.2. Apparatus and stimuli

A Philips 109B5 CRT monitor was used at a resolution of 1024×768 (85 Hz), controlled by a Dell Optiplex 9020 running 64-bit Windows. Stimulus presentation was controlled using Presentation software (Neurobehavioural Systems). Responses were executed with the index fingers of both hands by pressing the "Z" and "M" keys of a standard QWERTY keyboard.

The numbers 1 through 9 (excluding 5) served as primes. Forced-choice targets were the numbers 2, 4, 6 and 9, and the "#" served as the free-choice signal. Primes and targets were 10 mm high and 5–7 mm wide. The masks were constructed from a 3×3 matrix randomly filled with overlapping letters (all letters except "I" were used, and were in upper and lower case). The resulting masks extended approximately 20 mm in height and 23 mm in width. All characters were presented in white on a black background.

Every trial started with the presentation of a random letter mask for 70 ms (see Fig. 1). Then, the prime was presented for 35 ms followed by another random letter mask for 70 ms. The target was presented immediately after for 200 ms. Participants could respond within a time window of 1500 ms. Incorrect and late responses were indicated by a buzz and visual feedback (e.g., "WRONG" or "Too Late"!).

2.3. Procedure and design

Participants sat in a dimly lit room facing a computer screen at a viewing distance of 50 cm. They were informed that a digit between 1 and 9 would appear centrally on the screen, and were instructed to classify digits as less than or greater than