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Assessment of learned changes in stimulus salience as a consequence of preexposure to a single stimulus: Use of a change blindness task[☆]

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ABSTRACT

In a preexposure phase, all the participants were instructed to conduct a task involving mental mathematical operations. For Group EXPOSED, the instructions for this task, and the operations to be performed, were introduced by the image of a robot. Group CONTROL was not exposed to the image of the robot during this phase. At the beginning of the subsequent change blindness phase, all the participants were exposed to the image of the robot for 60 s. During this time, they were informed that several changes were to be included in that image, and that their task was to detect the greatest number of possible changes. Immediately after, a sequence of eight 2-s. screens with the image of the robot was initiated, and a blank screen lasting 0.5 s. was interspersed between them. The original image of the robot was presented first, and 12 changes were progressively included on the following screens. The changes most easily detected in Group CONTROL were detected less readily in Group EXPOSED, and the changes least easily detected in Group CONTROL were more readily detected in Group EXPOSED. These results are explained as a consequence of a salience-reducing effect produced by preexposure that would first affect the initially most salient stimulus features, thereby increasing the relative salience of the initially least salient features.

1. Introduction

Nonreinforced preexposure to a stimulus reduces both its ability to evoke its unconditioned response (UR) and the ease with which it becomes established as a conditioned stimulus (CS) when it is subsequently paired with an unconditioned stimulus (US). These two phenomena, known respectively as *habituation* and *latent inhibition*, are not the only consequences of stimulus preexposure. Appropriate non-reinforced experience with a stimulus brings about changes in the way in which it is perceived. This latter phenomenon is called *perceptual learning* (see Hall, 1991; for a review of the three phenomena). These three phenomena have been interpreted as being mediated (at least in part) by the ability of the non-reinforced exposure to reduce the effectiveness with which the stimulus is processed. A less processed stimulus will evoke its UR less effectively (habituation) and will also enter into associations with other events less readily (latent inhibition). From this perspective, habituation and latent inhibition are thus taken to reflect a reduction in the processing of the whole stimulus.

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Some examples of perceptual learning, however, have been taken to reflect a differential reduction in the effectiveness, or salience, of the features that comprise the stimuli. The aim of the present study is to provide evidence of this sort of perceptual learning mechanism.

Perceptual learning has been traditionally inferred from the observation that preexposure to a variety of stimuli brings about an enhancement in the ease with which they can be discriminated (e.g., Gibson & Walk, 1956). It is widely accepted that a variety of mechanisms contribute to producing this facilitating effect (e.g., Hall, 2003; Hall & Rodríguez, 2016a; McLaren & Mackintosh, 2000; Rodríguez & Alonso, 2014), but perhaps the simplest account is in terms of the salience-reducing mechanism mentioned above. Let us consider, for example, the case in which two stimuli, AX and BX (where A and B represent the distinctive or unique features of the stimuli, and X represents their common features) are preexposed. During this preexposure, X will be presented twice as often as A and B, thus suffering a more frequent and deeper loss of effectiveness. Thus, given that A and B are relatively more salient than X after preexposure, discrimination between AX and BX will be accomplished more readily (e.g., Hall & Rodríguez, 2016a; McLaren & Mackintosh, 2000).

At first sight, it might appear that this simple mechanism of differential reduction of stimulus salience is not applicable to the other instances of perceptual learning in which preexposure to a single stimulus enhances its discriminability (e.g., Rodríguez & Alonso, 2011). In these cases, all the features of the preexposed stimulus are presented equally often, and therefore, in principle, should be equally affected by the salience-reducing effect of exposure. However, other factors must be considered, such as, for example, the initial salience of the exposed features and the widely accepted assumption of a limited capacity to process all the stimuli present in a given situation with the same level of effectiveness. Let us consider the case of a stimulus *Aa*, where *A* represents its initially high salient features and *a* represents its initially low salient features. On the early stimulus presentations, the limited processing resources will be devoted to processing the more salient *A* features and the initially less salient *a* features will be thus overshadowed. This overshadowing will hinder the processing of these less salient features along with their temporal and spatial relationships with the remaining features (thereby impairing their integration into the central representation of the entire stimulus).

Repeated stimulus presentations, however, might change this situation. The salience-reducing mechanism will be expected to act first (and to a greater extent) on those features of the stimulus most effectively processed. This is to say that the *A*-features will suffer a greater reduction in salience than the *a*-features during preexposure, thus increasing the relative salience of (and allowing the effective processing of) these initially non-salient features. This change in the way in which stimulus *Aa* is perceived should be revealed, for example, by better performance in subsequent discrimination tasks in which the *a*-features serve to distinguish the *Aa* stimulus from other similar stimuli (*Ab*, *Ac*,. . .). In the present study, however, we looked for more direct evidence of these sorts of changes in stimulus salience by making use of a well-known paradigm in the field of attention, referred to as *change blindness*.

Change blindness (CB) is a failure to notice changes in a visual scene or stimulus, when these are introduced during a brief interval of time in which the stimulus is masked or hidden (e.g., Simons & Ambinder, 2005; Simons & Rensink, 2005; see also Goddard & Clifford, 2013; and Simons, Franconeri, & Reimer, 2000, for less common instances of the effect in the absence of a visual disruption). This phenomenon has been well documented in studies using a wide variety of stimuli and tasks with humans (e.g., Ahlstrom & Suss, 2015; Bredemeier & Simons, 2012; Calvillo & Jackson, 2014; Fitzgerald, Oriet & Price, 2016; Jingling & Yeh, 2007; Mack & Rock, 1998; Most, Scholl, Clifford, & Simons, 2005; Neisser & Becklen, 1975; Simons & Chabris, 1999; Simons & Jensen, 2009), and also with non-human animals, such as pigeons (e.g., Herbranson & Davis, 2016), chimpanzees (e.g., Tomonaga & Imura, 2015) and macaques (e.g., Cavanaugh & Wurtz, 2004). One of the most common procedures used to study the change blindness phenomenon in humans is known as the flicker task (Rensink, O'Reagan & Clark, 1997). In this procedure, the participants are informed that they are going to be exposed repeatedly to a sequence of screens with a target image or scene. They are also warned that in some screens a change will be introduced in the target, their task being to try to find the change. The sequence of screens usually consists of repeated alternations of the original and the modified image, separated by a blank screen that serves to mask the introduction of the change in the modified image (original-blank-changed-blank-original-blank. . .). Although the participants know that some change is occurring, they often fail to detect it (i.e., CB happens). A robust finding in the change blindness literature is that changes to attended objects are more detectable than changes to unattended objects (Kevin O'Reagan, Deubel, Clark & Rensink, 2000). Taking all this into account, we adapted a flicker task in order to assess the attentional changes that may occur during exposure to a single stimulus. That is, we used the change blindness procedure as an attentional tracker to detect variations in the salience of the stimulus features as a consequence of its prior exposure.

The experiment consisted of two phases. All the participants performed an irrelevant task in Phase 1 (which served to provide exposure to the target stimulus in the exposed condition), and a change blindness task in Phase 2. The masking task of Phase 1 consisted of performing several mathematical operations. The operations were presented one by one, and successively, on different screens. For participants in Group EXPOSED, the image of a robot (the target stimulus; see Fig. 1) introduced the mathematical operations that were to be performed. Participants in Group CONTROL, however, did not receive preexposure to the image of the robot in Phase 1. In the subsequent change blindness phase, all the participants were first allowed to see the image of the robot for 60 s during which they were informed that several changes were to be included in that image, and that their task was to detect the greatest number of possible changes. Immediately after, a sequence was initiated in which screens with the image of the robot were alternated with blank screens. The original image of the robot was presented first, and 12 changes (see Fig. 1) were progressively added in the subsequent screens with the image of the robot. Performance of Group CONTROL on the change blindness task was taken to assess the initial attention to (or the