Behavioural Processes 157 (2018) 102–105

Contents lists available at ScienceDirect

Behavioural Processes

journal homepage: www.elsevier.com/locate/behavproc

Overshadowing between visual and tactile stimulus elements in an object recognition task

W. David Stahlman*, Mercedes McWaters, Erica Christian, Eric Knapp, Andrea Fritch, Jennifer R. Mailloux

Department of Psychological Science, University of Mary Washington, Fredericksburg, VA, USA

ARTICLE INFO

Keywords:
Overshadowing
Potentiation
Multisensory input
Haptics
Cue competition

ABSTRACT

In recent decades there has been great progress in discovering the conditions under which cue competition occurs during animal learning. In humans, however, the evidence remains equivocal regarding the degree to which stimuli compete with one another for behavioral control. We report here the results of a single experiment wherein thirty-nine college students completed a novel cue competition task with visual and tactile stimuli. Participants visually and/or haptically examined a series of novel objects. They were then asked to select the objects with which they had interacted from a larger pool of both novel and familiar objects. Potentiation (or facilitation) by simultaneous visual and haptic inspection was possible. Alternatively, stimulus elements may have competed with one another (i.e., overshadowing), which would present as poorer recognition at test for objects to which participants had simultaneous, dual-modality training exposure. We report the latter effect. We situate these findings in the broader context of associative learning and suggest that our data is relevant to applied settings.

1. Introduction

Psychological science has origins in the investigation of reflexive behavior, wherein individual stimuli unconditionally elicit particular responses (e.g., Sherrington, 1906). The science developed as researchers began to focus on how acquired (i.e., learned) behavior was conditionally elicited by stimuli (after Pavlov, 1927). Presenting compound stimuli in conditioning procedures has led to further investigation of the processes underlying cue competition.

Pavlov (1927) is credited with studying the first instance of cue competition, known as *overshadowing*. Overshadowing is characterized by reduced ability of a cue to elicit conditioned behavior due to its relationship with other stimuli predictive of the outcome. For example, while an isolated tone may elicit a strong salivary response if presented repeatedly with food (i.e., Tone→Food), it likely will elicit a lesser response if it had been predictive of food only in conjunction with a light (i.e., Tone + Light→Food). Explorations of cue competition were rare until the 1960’s, when the advent of the so-called “cognitive revolution” and the discovery of the blocking effect (Kamin, 1969) spurred a flurry of model building (e.g., Mackintosh, 1975; Pearce and Hall, 1980; Rescorla and Wagner, 1972). Despite important distinctions, nearly all associative learning models predict behavior conditioned to an element of a compound stimulus should be reduced relative to a control in which an element had been trained alone.

Consider a fear-conditioning scenario in which an experimental group receives Tone + Light→Shock training, while a control group receives Tone→Shock training. Most models predict the control group will show greater conditioned fear when subsequently tested on Tone-alone trials, irrespective of the underlying mechanism. While this is borne out in typical empirical preparations (i.e., those in which the compound stimuli have auditory and visual elements; e.g. Matzel et al., 1985), this prediction regularly fails in circumstances in which stimulus compounds predictive of illness have gustatory and olfactory elements (e.g., Palmerino et al., 1980; Rusiniak et al., 1979). Indeed, the inclusion of a flavor cue during training may increase, rather than decrease, the efficacy of an aroma in producing conditioned aversion. This sort of effect is known as *potentiation.* There have also been a few recent examples in nonhuman animals of potentiation with elements that are neither gustatory nor olfactory (e.g., in spatial learning; Graham et al., 2006).

In human children, Kalenine et al. (2011) found that geometric shape recognition was better when haptic (i.e., active touch) stimulation was added to visual stimulation, and Bara et al. (2007) found that an intervention with haptic and visual elements improved reading more

* Corresponding author.
E-mail address: wdstahlm@umw.edu (W.D. Stahlman).

https://doi.org/10.1016/j.beproc.2018.08.008
Received 31 January 2018; Received in revised form 14 June 2018; Accepted 23 August 2018
Available online 22 September 2018
0376-6357/

than did a visual-only intervention. Also, postgraduate biochemistry students learned more about molecular structure and function when they were given multimodal (i.e., haptic and visual), compared to unimodal, visual feedback (Bivall et al., 2011). However, these studies do not provide unequivocal evidence for potentiation. They typically use techniques quite different from those used in traditional investigations of learning, which makes their interpretation challenging. For example, Bivall et al.'s (2011) training procedure involved students' direct interaction with virtual molecular models, but post-training assessment was done via administration of a written test rather than via interaction with the models. Such procedures may be useful in applied contexts in which both strict control of stimulus presentation between training and testing are secondary to practical matters (e.g., pedagogy); however, such procedures fail to illuminate the underlying phenomena of interest due to relaxed control of stimulus presentation and lack of continuity between training and testing.

We examined whether presentation of both haptic and visual stimulation during training aids or impairs object recognition at test. We separated in space the stimulus properties (i.e., haptic and visual) of the target by simultaneously presenting two identical objects in separate chambers of a box. Then, participants were asked to identify the objects they had observed during training from a serial array that included novel objects. If stimulus elements integrate to positively affect object recognition, we should observe improved object recognition (i.e., potentiation) when participants are trained with haptic *and* visual object properties compared to when they are trained with haptic *or* visual information. Alternatively, if stimulus elements compete to affect object recognition, we should observe greater object recognition at test when participants had received unimodal training (i.e., overshadowing).

2. Method

2.1. Participants

Thirty-nine (7 men, 32 women) right-handed volunteers were recruited from a participant pool of undergraduates enrolled in introductory psychology at the University of Mary Washington (UMW). Participants were 18–21 years old and self-reported normal or corrected-to-normal eyesight and normal sensorimotor function. Participants received course credit as compensation. All experimental work complied with relevant ethical guidelines and was approved by UMW's Institutional Review Board.

2.2. Materials

The apparatus used to present objects was a wooden, horizontally-oriented, two-chambered box (60.5 cm × 32.0 cm × 30.0 cm; see Fig. 1A). Platforms (5.0 cm × 5.0 cm × 4.0 cm), upon which objects could be placed, were located in the centers of both chambers. Two holes were drilled into the center of each platform into which the objects could be secured by two dowels (each 3.0 cm long × 0.4 cm in diameter). Felt curtains were attached to the front and back of the left chamber; its front curtain could be lifted away so the participant could view an object inside. Another curtain, composed of two overlapping felt panels through which participants could reach but not see, was attached to the front of the right chamber.

We created 48 identical pairs of novel stimulus objects (cf. Newell et al., 2001). Each object was constructed from six blue LEGO™ bricks (3.1 cm × 1.5 cm × 1.1 cm) glued together after being stacked vertically and asymmetrically to create 48 unique configurations (see Fig. 1B). After construction, each object measured 4.7 cm high; width and depth varied slightly based on the specific configuration of each object pair.

2.3. Procedure

Participants were seated in front of a table upon which the training apparatus was placed. Their right thumbs were affixed to the proximal phalange of the right index finger with tape. The researcher randomly chose eight pairs of objects to serve as the pool for a training block. One pair was then selected and the object(s) placed into the apparatus. Objects placed in the haptic chamber were rotated 180° around the vertical axis relative to ones in the visual chamber (see Newell et al., 2001, for evidence that viewpoint preference for object recognition differs thusly for visual and haptic modalities). Participants were instructed to feel the back of haptic objects with the fingers of their right hand. The participant was then allowed to study the object(s) for 30 s; depending on the trial block, this was done haptically-only, visually-only, or both haptically and visually. This was repeated four times, with a different randomly selected pair, without replacement, from the pool of eight. Each trial within a training block was of the same type (e.g., haptically-only).

Object recognition testing was then conducted. In a random order, the experimenter serially and individually placed one member of each object pair from the pool into the appropriate chamber. Testing was always unimodal; testing following unimodal training was always in the modality of training. In other words, if the participant had received visual-only training on a given block of trials, the immediately subsequent testing was done visually. Participants were asked to verbally indicate in each test trial whether they had observed the object during the immediately preceding training block. Eight trials were presented in each of four test blocks (i.e., a total of 32 test trials); within each, four test objects were ones that had been present in the preceding training block, while the others were the remaining objects from the pool that

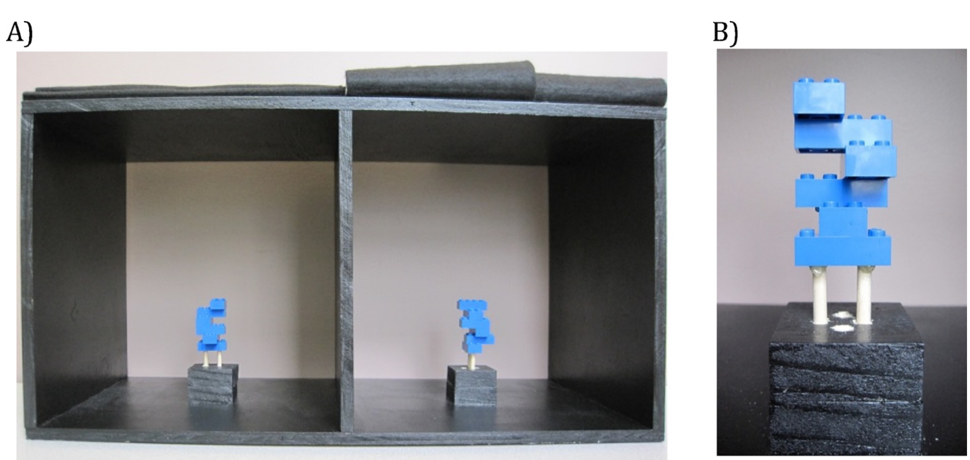

Fig. 1. A: Apparatus used to present objects visually (left chamber) and haptically (right chamber). B: A sample object as it could be mounted in the chamber.