Vision Research 61 (2012) 70–76

Contents lists available at SciVerse ScienceDirect

Vision Research

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

Fast task-irrelevant perceptual learning is disrupted by sudden onset of central task elements

Virginie Leclercq, Aaron R. Seitz *

Department of Psychology, University of California – Riverside, Riverside, CA, USA

ARTICLE INFO

Article history:
Received 10 March 2011
Received in revised form 14 July 2011
Available online 24 July 2011

Keywords:
Perceptual learning
Task-irrelevant perceptual learning
Visual memory

ABSTRACT

The basic phenomenon of task-irrelevant perceptual learning (TIPL) is that the stimulus features of a subject's task will be learned when they are consistently presented at times of reward or behavioral success. Recent progress in studies of TIPL has been made by the discovery of a fast form of TIPL (fast-TIPL), which can be observed with as little as a single trial of exposure. In the present study, we investigated the task-conditions required to observe fast-TIPL. We had participants perform a target detection task at fixation while scenes to memorize were presented peripherally. In some experiments the target was presented in a sequence of distractors (Experiments 2 and 4) and in others alone (Experiments 1 and 3). In each experiment we assessed whether learning for target-paired scenes was greater than that of nontarget-paired scenes. The results indicated an enhanced memorization for scenes paired with the targets in the experiments where the target was presented with distractors, but not in the experiments where distractors were not presented. We hypothesized that without the presentation of distractors the onset of the target was sudden and this may have exogenously drawn attention to the center of the display disrupting TIPL. This sudden onset hypothesis was experimentally confirmed in Experiment 5. We conclude that fast-TIPL, with its rapid time-course, and its production of learning for supraliminally presented stimuli, shows great promise as an efficient paradigm through which to understand mechanisms of learning.

© 2011 Elsevier Ltd. All rights reserved.

1. Introduction

Our perceptual systems receive abundant information from the environment. However, only some of this information is processed to the degree that it can later be reported. One framework for learning is that behaviorally relevant information will be best encoded. That is, that we do not simply learn aspects of the world based upon their statistics of occurrence, but instead that learning is gated by processes such as attention and reinforcement such that we learn best what is most relevant. In this framework, the phenomenon of task-irrelevant perceptual learning (TIPL) (Seitz & Dinse, 2007; Seitz & Watanabe, 2005, 2009) has captured a growing interest in the field of perceptual learning and has led to specific predictions regarding how reinforcement from task-performance (Seitz, Lefebvre, et al., 2005; Seitz & Watanabe, 2003) or delivery of reward (Seitz, Kim, & Watanabe, 2009) can lead to better processing of stimuli, even when they are task-irrelevant.

The basic phenomenon of TIPL (Seitz & Watanabe, 2009) is that the stimulus features of a subject's task are learned when they are consistently presented at times of reward or behavioral success. In the standard TIPL paradigm (Seitz & Watanabe, 2003), subjects have to conduct a relevant task, for example detecting a target in a rapid serial visual presentation (RSVP) of stimuli (e.g. light-gray letters among black letters), while irrelevant stimuli are consistently paired with the targets of the RSVP task (Seitz & Watanabe, 2008). The results of these procedures show that subjects learn, and become better at detecting or discriminating, the target-paired task-irrelevant stimuli (Watanabe, Nanez, & Sasaki, 2001). Seitz and Watanabe (2003) found that TIPL occurred as the result of temporal pairing between the presentation of a task-irrelevant, motion stimulus and a task-target. This result suggests that perceptual learning of the irrelevant information is not passive, but occurs for information that is consistently presented at behaviorally relevant times. Thus, TIPL could be related to a reward-based learning mechanism that reinforces perceptual information presented during a rewarding event (Seitz & Watanabe, 2005), even when that information is not expected nor explicitly identified. By now TIPL has been found for motion processing (Watanabe et al., 2002), orientation processing (Nishina et al., 2007), critical flicker fusion thresholds (Seitz, Nanez, et al., 2005, 2006), contour integration (Rosenthal & Humphreys, 2010), auditory formant processing (Seitz et al., 2010), and phonetic processing (Vlahou, Seitz, & Protopapas, 2009) and thus appears to be a basic mechanism of learning in the brain that spans multiple levels of processing and sensory modalities.

* Corresponding author.
E-mail address: aseitz@ucr.edu (A.R. Seitz).

0042-6989/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.visres.2011.07.017

Recent progress in studies of TIPL has been made by a number of labs with the demonstration of a fast form of TIPL (fast-TIPL) that can be found with as little as a single trial of exposure (Lin et al., 2010; Swallow & Jiang, 2010, 2011). These studies show that visual memory is enhanced for stimuli (photographs of urban and natural scenes or faces) that are paired with the targets of an RSVP task (white stimulus among black stimuli). Notably, in these experiments, the enhancement of visual memory is found for stimuli that are irrelevant to the RSVP tasks. Compared to slow-TIPL, in which, subjects do not have any task to perform concerning the stimuli presented alongside the RSVP task (i.e. moving dots) – thus the paired-stimuli are totally irrelevant to the subjects – in fast-TIPL, subjects are informed that they have to memorize the stimuli presented alongside the RSVP task (i.e. images of scenes or faces). Thus in fast-TIPL, compared to slow-TIPL, these paired images are important to the subjects, however, they are still irrelevant to the RSVP task in the sense that the paired images give absolutely no cue to answer to the RSVP task. Explanations for fast-TIPL mirror those of slow-TIPL. For example, Lin et al. (2010) suggest a mechanism where traces of visual scenes are automatically encoded into memory at behaviorally relevant points in time regardless of the spatial focus of attention. Swallow and Jiang (2010) suggest that detecting a target in one task may induce an "attentional boost" at the moment in time that the target appeared that facilitates the processing and encoding of information into memory. While the enhanced memorization found in these studies of fast-TIPL may involve some differences in underlying processes from the low-level perceptual learning that has been the primary focus of studies of slow-TIPL, the strong parallels between the experimental paradigms and results suggests that there are overlapping mechanisms, and we thus suggest that fast-TIPL and slow-TIPL are related phenomena.

The studies of fast-TIPL make a number of findings regarding the processes of learning. First, they show that TIPL can occur on the time scale of a single trial, rather than the many days of exposure typically required to observe slow-TIPL. Second, they show that processing of stimuli that are relevant to the subject (although not relevant to the RSVP task), and not only irrelevant stimuli, can be enhanced through TIPL. Third, they show that TIPL can occur for salient stimuli. Consequently, the use of such fast-TIPL procedures can lead to more efficient methods by which to investigate the processes involved in TIPL and to the generalization of the TIPL paradigm to study learning of stimuli that are task-relevant (Seitz & Watanabe, 2008).

While these recent studies of fast-TIPL by Lin et al. (2010) and Swallow and Jiang (2010) are promising in understanding the mechanisms underlying TIPL, their procedures are quite different. In Lin et al. (2010), in each trial a RSVP stream of 15 dark letters (distractors) and 1 white letter (target) was each paired with a unique image. At the end of each trial, participants reported the target letter and whether they recognized a test image (either a target-paired image, a distractor-paired image, or an image not presented in that trial). In the procedure used by Swallow and Jiang (2010), participants were asked to memorize a serie of images paired either with white squares, to which they gave an immediate response, or black squares, which were ignored. A memory test was conducted only after the completion of 10 blocks, each containing approximately 170 images. Given these procedural differences in the study of fast-TIPL it is unclear the important aspects of these tasks that give rise to learning.

In the current study, we looked to determine the key task conditions that would lead to fast-TIPL. We started (Experiment 1) with a simple detection task (e.g. Swallow & Jiang, 2010) without any distractors and with a scene recognition task after each trial (e.g. Lin et al., 2010). With this procedure, we expected to replicate results obtained in previous studies of fast-TIPL, that is an enhanced memorization for information presented with task-targets. However, we found that this procedure failed to produce fast-TIPL. Instead, we found that the inclusion of distractors into the design was needed to get enhanced memorization during target-processing (Experiment 2). We then replicated these findings (Experiments 3 and 4) by showing that the presence of distractors was also needed to find fast-TIPL in the context of a RSVP letter identification task (Lin et al., 2010; Seitz & Watanabe, 2003; Watanabe et al., 2001). In Experiment 5, we demonstrate that these results can be explained by the sudden onset of the target, which disrupted the observation of TIPL in the absence of distractors.

2. Experiment 1

In this first experiment, we examined whether enhanced memorization would occur for scene images paired with targets of a simple detection task.

2.1. Methods

Sixteen participants (19 y.o. ± 1 y.o.; 10 females, 6 males) gave informed consent to participate in this experiment, which was approved by the University of California, Riverside. All participants reported normal or corrected-to-normal visual acuity and received course credit and financial compensation for the 1-h session. Prior to testing, participants were familiarized with the 192 scenes that were to be used in the experiment by viewing each image for 2 s. After this, participants performed a practice block of 24 trials. Each participant was then tested for a total of 240 trials, in 10 blocks of 24 trials. Blocks were separated by brief breaks.

2.2. Apparatus and stimuli

An Apple Mac Mini running Matlab (Mathworks, Natick, MA) and Psychtoolbox Version 3 (Brainard, 1997; Pelli, 1997) was used for stimulus generation and experiment control. Stimuli were presented on a 22″ monitor with resolution of 1680×1050 resolution, and a refresh rate of 60 Hz. Participants sat with their eyes approximately 60 cm from the screen. The backgrounds of all displays were a mid-gray (luminance of 92 cd/m^2). Display items consisted of 192, 700×700 pixel (18.3° of visual angle), photographs depicting natural or urban scenes from eight distinct categories (i.e., mountains, cityscapes, etc.). Scenes were obtained from the LabelMe Natural and Urban Scenes database (Oliva & Torralba, 2001) at 250×250 pixels of resolution, then up-sampled to 700×700 pixels of resolution. The average luminance of all images was 79 cd/m^2 (standard deviation of 29).

2.3. Procedure

Each trial began with the presentation of a black fixation cross (0.3° of visual angle) for 450 ms. This presentation was followed by a rapid sequence of 16 full-field scenes. Each scene was presented for 133 ms, followed by an ISI of 367 ms, during which only the fixation cross was presented, for a SOA of 500 ms (Fig. 1A).

2.3.1. White square detection task

A gray aperture (1° of visual angle and luminance of 92 cd/m^2) was presented in the center of each scene, thus centered in the middle of the screen. In each trial, a fixation cross was presented at central fixation in the middle of the gray aperture for 15 scenes, and a white square (0.75° of visual angle and luminance of 251 cd/m^2) was presented in the middle of the gray aperture for 1 scene. The white square had the same onset and offset time as the image with which it was paired. The white square could only appear with

Download English Version:

https://daneshyari.com/en/article/4034009

Download Persian Version:

https://daneshyari.com/article/4034009

Daneshyari.com