Consciousness and Cognition 35 (2015) 88–97

Contents lists available at ScienceDirect

Consciousness and Cognition

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

Identifying words that emerge into consciousness: Effects of word valence and unconscious previewing

Simone C. Prioli [a], Todd A. Kahan [b,*]

[a] Department of Neuroscience, Bates College, United States
[b] Department of Psychology, Bates College, United States

ARTICLE INFO

Article history:
Received 27 November 2014

Keywords:
Continuous flash suppression
Cognitive aftereffects
Unconscious word reading
Word valence
Attentional capture

ABSTRACT

Words with negative valence capture attention and this increase in attentional resources typically enhances perceptual processing. Recently, data using continuous flash suppression (CFS) appear to contradict this. In prior research when Chinese words were unconsciously presented in CFS and contrast was raised until the word was identified, RTs to identify words with negative valence were slower than RTs to words with neutral valence. This result might be limited to situations where a logographic writing system is used and could reflect a type of cognitive aftereffect where previewing the word causes habituation. Data ($N = 60$) indicate that results generalize from a logographic (Chinese) to an orthographic writing system (English). In addition, when words were previewed in CFS RTs were slowed for words with negative valence relative to words with neutral valence and this was *reversed* when words were shown binocularly. Implications for theories of unconscious word processing and cognitive aftereffects are discussed.

1. Introduction

It is evolutionarily advantageous for organisms to prioritize the processing of emotion-laden stimuli since emotional information may provide cues that are relevant for survival. As such, it is not altogether surprising that numerous studies have found a processing advantage for emotion-laden stimuli relative to neutral stimuli (e.g., Lang et al., 1998; Schupp, Junghöfer, Weike, & Hamm, 2003). In addition, since aversive stimuli may signal potential harm, it is also not unexpected that negatively valenced faces and words may be especially good at capturing visual attention (e.g., Anderson & Phelps, 2001; Estes & Adelman, 2008a, 2008b; Fox, Russo, Bowles, & Dutton, 2001; Kuperman, Estes, Brysbaert, & Warriner, 2014; McKenna & Sharma, 1995; Nasrallah, Carmel, & Lavie, 2009; Pratto & John, 1991).

In some instances the capture of attention by aversive relative to neutral stimuli will facilitate performance and in other instances capture will impair performance; Nasrallah et al. (2009) nicely showed that the reason for discrepant findings likely reflects the experimental task. When the task requires a person to respond to a non-emotional dimension of the stimulus, for example responding to the color of emotion-laden words (Williams, Mathews, & MacLeod, 1996) or making a lexical decision to emotion-laden words (Kuperman et al., 2014), the misdirected capture of attention by emotion will impair performance. However, when the task involves detecting the emotion-laden word itself, rather than responding to some other aspect of the stimulus, the enhanced sensitivity to negative words results in improved performance (Nasrallah et al., 2009;

* Corresponding author at: Department of Psychology, Bates College, 4 Andrews Road, Lewiston, ME 04240, United States. Fax: +1 207 786 8338.
E-mail address: tkahan@bates.edu (T.A. Kahan).

http://dx.doi.org/10.1016/j.concog.2015.04.005
1053-8100/

Ogawa & Suzuki, 2004; Sheikh & Titone, 2013). In the case of Stroop and lexical decision tasks, the results reflect processes other than what Nasrallah et al. (2009) referred to as preattentive perceptual sensitivity.

However, Yang and Yeh (2011) reported data that appear to run counter to the conclusion that negative emotion-laden words will benefit from enhanced perceptual sensitivity. In their experiments Yang and Yeh (2011) presented words "unconsciously" to participants by displaying the words to a person's suppressed eye in continuous flash suppression. Continuous flash suppression (CFS), developed by Tsuchiya and Koch (2005), is a form of binocular rivalry where dichoptic stimulation of the eyes results in suppressed awareness of one eye by the other. Unlike traditional binocular rivalry approaches (e.g., Breese, 1909) where the information presented to the two eyes is static and where awareness of the visual information teeter totters between the two eyes cyclically, in CFS one eye receives rapidly changing information (e.g., Mondrian patterns) while the other eye receives a static image. When this is done a person's conscious experience is of the rapidly changing information while the non-changing static information remains hidden from consciousness for an extended period (Tsuchiya, Koch, Gilroy, & Blake, 2006). Despite people being unaware of the information shown to the suppressed eye, there is now evidence that pictures of tools (Fang & He, 2005), faces (Jiang, Costello, & He, 2007; Jiang & He, 2006), and words (Jiang et al., 2007; Yang & Yeh, 2011) are all processed unconsciously when seen in the suppressed eye. In addition, Jiang et al. (2007) reported that when the contrast of the information shown to the suppressed eye is gradually increased, meaningful stimuli reach consciousness more rapidly than meaningless items (e.g., Hebrew words are noticed more rapidly than Chinese characters for Hebrew readers and the reverse is found for Chinese readers). Using this same technique, Yang and Yeh (2011) reported that words with negative valence take longer to release from suppression than words with neutral valence. Though these data add support for the controversial claim that word meaning can be processed unconsciously (which was the primary purpose of their study and a point we return to in the General Discussion) these results appear to run counter to the notion that aversive information will benefit from enhanced perceptual processing.

1.1. Cognitive aftereffects: A possible explanation

One possible consequence of previewing a stimulus for an extended period is that the cells that respond to this stimulus may become fatigued, leading to aftereffects. In fact, so-called unconscious perceptual aftereffects as a result of previewing stimuli for an extended period in CFS have now been reported for face shape (Stein & Sterzer, 2011), eye gaze (Stein, Peelen, & Sterzer, 2012), and motion perception (Kaunitz, Fracasso, & Melcher, 2011; Maruya, Watanabe, & Watanabe, 2008). Since perceptual aftereffects can occur after continued viewing in CFS we speculated that cognitive aftereffects, of the type described by Huber and colleagues, might also arise when stimuli are viewed in this manner (see Huber, 2008; Huber & O'Reilly, 2003). The basic premise of cognitive aftereffects is very much analogous to what happens in classic examples of perceptual aftereffects (color, edges, motion, etc.) where fatiguing the neural architecture with continued stimulation results in a refractory period where it is now more difficult to perceive that stimulus again. In the case of cognitive aftereffects this may help reduce source confusion by making it more difficult for a person to falsely see an old item as new, and making it easier to detect new information. Huber (2008) argued that this theoretical account may, in part, help to explain results from a number of experimental paradigms including, but not limited to: masked priming, the attentional blink, inhibition of return, repetition blindness, and the negative compatibility effect.

If we extend this theoretical framework to Yang and Yeh's (2011) experiments, it is possible that attention was unconsciously drawn to the word with negative valence since attending to aversive stimuli may be evolutionarily advantageous (Kuperman et al., 2014). Numerous studies have found that attention can be drawn to a cue that people are unaware of seeing (e.g., Ansorge, Horstmann, & Scharlau, 2011; Hsieh, Colas, & Kanwisher, 2011; Ivanoff & Klein, 2003; McCormick, 1997; Mulckhuyse & Theeuwes, 2010). In fact, Lamy, Alon, Carmel, and Shalev (2015) report data from several cuing experiments where they compared performance in situations where people either were or were not aware of a cue shown in continuous flash suppression. Importantly, their results indicate that attention is captured equally well with or without awareness. As such, if attention is unconsciously drawn to words with negative valence, then this increase in attention would likely result in increased firing rates amongst cells that respond to words with negative relative to neutral valence. Increases in the rate of neural firing with increases in attention have been shown in both studies of non-human animals using single cell recording techniques (e.g., Bisley & Goldberg, 2003; Moran & Desimone, 1985) as well as human participants using brain imaging techniques (e.g., Peelen & Kastner, 2014; Çukur, Nishimoto, Huth, & Gallant, 2013). In fact, since the increase in rates of firing for attended stimuli is typically magnified for higher-level cognitive representations relative to lower-level representations (see Maunsell, 2004) then it follows that the continued presentation of a word in CFS could, in principle, result in a cognitive aftereffect of the type described by Huber (2008). This would make it more difficult for a word with negative valence to be detected since the neural pattern of activation for this word would be more heavily taxed during CFS than the pattern of activation for a word with neutral valence. Since aftereffects do not occur when stimuli are shown briefly (see Huber, 2008) we predict that if words were shown to both eyes then the pattern would be quite different. Specifically, if the contrast of words were increased from very light gray on a white background to darker gray on a white background, and if the words were viewed with both eyes (rather than CFS), then the opposite pattern of detection times may be found. Here, if attention is drawn to a word with negative valence more quickly than a word with neutral valence the increase in attention would speed detection times.

The current experiment had two major goals. The first goal was to examine whether Yang and Yeh's (2011) results will replicate using English words, rather than Chinese characters. As Yang and Yeh (2011) point out, Chinese is a logographic