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The roles of remembering and outshining in global environmental context-dependent recognition

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ABSTRACT

The present study investigated whether odor and background-music dependent recognition is best explained by the outshining account, consisting of the encoding-specificity and the outshining principles. In contrast, the ICE theory posits that recognition of a past episode involves judgment processes based on global activation of the item, the context, and the ensemble information in the probe and memory. Experiments 1 and 2 manipulated odor contexts, and Experiment 3 manipulated background-music context. In the three experiments, a total of 384 undergraduates intentionally studied a list of unrelated words. After a filled 5-min retention interval, participants received a recognition test on paper. In the same-context (SC) condition, the same odor or musical piece was presented during both study and test, whereas in the different-context (DC) condition, different odors or musical pieces were presented at study and test. Context-dependent recognition discrimination was found when the hit rate in the DC condition was low but not when it was high. Furthermore, context-dependent recognition discrimination was found when there was a positive context-dependent effect for the hit rate and a negative effect for the false alarm rate, which is a context-based mirror effect. Failure to find context-dependent recognition discrimination occurred when there was no effect for either the hit rate or the false alarm rate. The least-squares regression lines relating the effect sizes of d′ for the DC hit rate, for the odor and background-music contexts, along with previous data of place context, showed that the effect sizes were inversely proportional to the DC hit rate. The present results are best explained by the outshining account, but not by the ICE theory.

Introduction

An episodic-memory trace consists of focal information and context. The focal information refers to the salient part of the episode, and the context refers to the other parts of the episode. Because context consists of various types of information, it can be classified in various ways (Glenberg, 1979; Isarida & Isarida, 2014a; Smith, 1988). For example, contexts can be classified into environmental and semantic contexts. Environmental context refers to incidental information about the environment in which the focal information is processed (Isarida & Isarida, 2014a; Smith, 1988), whereas semantic context refers to semantic or verbal features from the item being processed (Light & Carter-Sobell, 1970; Thomson & Tulving, 1970). Additionally, contexts can be classified into global and local contexts according to the associative generality related to the rate of change (Glenberg, 1979). Global context can associate with all the elements of an event, because it typically remains stable or changes very slowly during the event (Glenberg, 1979). On the other hand, local context can associate with a limited number of elements of an event, because it changes relatively quickly (Glenberg, 1979).

The present study addresses the functions of environmental context. Environmental context was once considered to be almost identical to global context, whereas semantic context corresponded to local context. However, certain environmental contexts have been recently found to function as local context rather than as global context. For example, changing background colors item by item is necessary to produce a background-color dependent effect in free recall (Isarida & Isarida, 2007). If five or more items are successively presented against the same background color, then the background-color dependent effect will be eliminated. Additionally, the items presented against the same background color do not cluster in free recall by the background color (Isarida &

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Isarida, 2007). Furthermore, when six items per computer screen were simultaneously presented, the items from the same screen were clustered together, whereas the items from different screens but sharing the same color were not clustered together (Sakai, Isarida, & Isarida, 2010). These findings imply that each screen forms a separate episode independently of the attributes of the screen, such as color.

These characteristics of background-color context should contrast well with those of global environmental contexts, such as place (Isarida & Isarida, 2010; Smith, 1988; Smith & Vela, 2001), odor (Isarida et al., 2014; Pointer & Bond, 1998; Schab, 1990), and background music (Balch, Bowman, & Mohler, 1992; Isarida, Kubota, Nakajima, & Isarida, 2017; Smith, 1985). Thus, the characteristics of background color should be called "local environmental context." Probably other visual contexts, such as simple visual context, a unique combination of foreground color, and background picture context should be also classified as local environmental contexts (Hockley, 2008; Murnane & Phelps, 1993, 1994, 1995; Murnane, Phelps, & Malmberg, 1999). These contexts of visual features of a computer screen are necessarily manipulated within lists, so that they almost always change item by item. Smith and Vela (2001) followed Glenberg's (1979) distinction between local and global contexts in terms of the associative generality caused by rate of change; for example, fast-changing corresponds to local environmental context and slow-changing corresponds to global environmental context.

The present study explores the principles that can explain global environmental context-dependent recognition. There have been two types of explanatory principles or theories. One is the encoding specificity principle (Tulving & Thomson, 1973) which proposes that the recognition processes involved in remembering past episodes use the items presented at test (probe) as retrieval cues. These recognition processes are basically the same as the recall processes. The other type of recognition principle proposes that the recognition processes involve matching between items in memory and the probe (e.g., Kintsch, 1970). Context information also influences the matching processes (e.g., Anderson & Bower, 1972). Furthermore, a variety of global matching theories state that an entire set of information in memory and in the probe are globally compared (see Clark & Gronlund, 1996). In particular, Murnane and his colleagues advanced theories adopting the functions of incidental contexts (Murnane & Phelps, 1993, 1994, 1995), and further developed the ICE (Item-Context-Ensemble) theory (Murnane et al., 1999). According to such matching processes, participants make memory-strength or familiarity-based recognition judgments.

The ICE theory posits that recognition of a past episode involves judgment processes based on global activation of the item (I), the context (C), and the ensemble information (E) in the probe and memory. Item is defined as any information that is central to the primary cognitive task being performed in the processing environment. Context is defined as any information that is incidental to the processing of items. Ensemble is defined as a type of information that a learner creates by combining or integrating item and context information. Note that ensemble is a unique type of information that is different from either item or context information considered alone. The respective patterns of match or mismatch between the three types of information (I, C, E) in memory and probe at a typical recognition test are as follows. Item information matches if the test item is old regardless of whether the test context is old or new. Similarly, context information matches if an item is tested in the old context regardless of whether the test item is old or new. In contrast, ensemble information only produces a match for old items with the corresponding old context. This is because the ensemble is a unique integration of the old item and the old context. For the ICE theory, Murnane et al. (1999) made an auxiliary hypothesis that the probability of ensemble formation is a function of the amount of meaningful content in the context information. More specifically, simple visual context is difficult to integrate into an ensemble with items, because it is poor in semantic information (Murnane & Phelps, 1993, 1994, 1995). In contrast, a background picture context is easy to integrate with items, because it is rich in semantic information (Murnane et al., 1999).

The ICE theory predicts that context matching will increase both the hit and false alarm rates. This is called a "concordant effect" (Hockley, 2008; Maddox & Estes, 1997). The ICE theory explains that the concordant effect, especially the positive context effect for the false alarm rate, is based on the greater memory strength or familiarity associated with an old context. The ICE theory predicts the concordant effect, regardless of whether an ensemble is formed or whether the old context is the same as or different from the study context. In contrast, the old context cannot serve as a retrieval cue for the new items. This is because the old context and the new items did not appear together, so that they did not associate with each other. Thus, the encoding specificity principle does not predict the concordant effect.

Most researchers have manipulated incidental information of digitally represented environments on a computer screen, such as background-color context (e.g., Isarida & Isarida, 2007; Rutherford, 2004), simple visual context (e.g., Murnane & Phelps, 1993, 1994, 1995), background-picture context (e.g., Hockley, 2008; Murnane et al., 1999), and video clips consisting of motion pictures with sound (e.g., Smith & Handy, 2014; Smith and Manzano; 2010). Most of these studies have provided evidence supporting the ICE theory (Dougal & Rotello, 1999; Hockley, 2008; Hockley, Bancroft, & Bryant, 2012; Murnane & Phelps, 1993, 1994, 1995; Murnane et al., 1999). Although the other two studies reported the results contrary to the ICE theory (Grupusso, Lindsay, & Masson, 2007; Macken, 2002), further examinations indicated that these results could be supportive of the ICE theory (Hockley, 2008; Hockley et al., 2012). These findings indicate that the ICE theory provides the most plausible explanation of environmental context-dependent recognition.

However, the generality of the ICE theory is questionable, although Murnane et al. (1999) claimed that the ICE theory can be applicable to any types of context. First, the ICE theory has not been demonstrated with any global environmental context but only with local environmental contexts (i.e., simple visual context and background picture context). Furthermore, there has been no evidence that such local contexts are functionally identical to global environmental contexts. Rather, the local environmental contexts may differ in functions or characteristics from the global environmental contexts.

The global environmental context-dependent effect is clear when nothing other than context is available as a retrieval cue, but unclear when any other cue is available. The global environmental context can associate with all to-be-remembered items, whereas specific retrieval cues provided by an experimenter can associate with one or a few items. Additionally, the cue strength is reported to be inversely proportional to the number of items associated with the cue (Watkins & Watkins, 1975). Therefore, the provided retrieval cues are likely to be stronger than the context cue, so that the effect of a weaker context cue is not manifested. More specifically, environmental context-dependent effects in uncued free recall are best explained by the encoding specificity principle (Tulving & Thomson, 1973), because only an environmental context serves as a retrieval cue. In contrast, a retrieval cue provided by an experimenter, in addition to the context cue, during cued recall usually suppresses the appearance of environmental context-dependent effects. According to Smith and Vela's (2001) meta-analysis, the lower end of the confidence interval of effect size (Cohen's d, Cohen, 1992) for cued recall was less than zero, although the mean effect size for cued recall ($d = 0.25$) was similar to that for uncued recall ($d = 0.29$).