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Conceptual processes involved in words and scenes context effect in face recognition

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ABSTRACT

Several studies have established the impact of conceptually similar context on the emergence of "Context-Effect" (CE). None of these studies included the Re-pair/rearrange condition at the test, which prevented them from being conclusive about the exact process (binding/ensemble or familiarity) that was affected by the conceptually similar context. To this end, in the present study faces (target to be remembered) were presented in the context of either words (W) or picture (P) scenes, and at test Re-pair was added as one of the context conditions. At test two groups were presented with the same context as in study (consistent condition) (WW & PP), and two groups with the inconsistent condition (WP & PW). Results showed no familiarity effect when only the conceptual match was preserved (i.e., inconsistent condition) and both effects of binding and familiarity when both conceptual and perceptual match were present (i.e., consistent condition). Thus, the semantic association between a face and context could serve as recognition cues even when modality has been changed, but the label remained constant.

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The specific elements upon which we focus in our surrounding environment, in an effort to remember, are referred to as "targets," and those that remain in the periphery of our attention are referred to as "context" (Mayes, MacDonald, Donlan, Pears, & Meudel, 1992; Schacter, Harbluk, & McLachlan, 1984). Memory for target information is improved when tested in the presence of the same learning context. This facilitative effect of contextual information is referred to in the literature as "context effect" (CE; Memon & Bruce, 1985; Vakil, Golan, Grunbaum, Groswasser, & Aberbuch, 1996). Extensive laboratory research on CE has been conducted with experimentally presented stimuli such as word lists (McKenzie & Tiberghien, 2004; Steyvers & Malmberg, 2003), pictures of objects (Levy, Rabinyan, & Vakil, 2008), or pictures of faces (Dalton, 1993; Vakil, Raz, & Levy, 2007).

The "butcher-on-the-bus" phenomenon described by Mandler (1980) demonstrates how in real life it is more difficult to recognise a person when he/she is in a different context than where initially encountered. Since Memon and Bruce's (1985) review, many more studies have confirmed the effect of context change, between encoding and retrieval, on face recognition (the focus of the present study). We wanted to concentrate only on studies that resemble real-life situations such as "butcher-on-the-bus," since the association between face and context is formed incidentally and not intentionally as in "paired associate learning" paradigms (see Hayes, Baena, Truong, & Cabeza, 2010).

Various types of context have been used to demonstrate CE on face recognition: hat-topped faces (Vakil et al., 2007), pairs of faces, where one is designated as target and the other as context (Bloch & Vakil, 2017; Winograd & Rivers-Bulkeley, 1977), faces with or without sunglasses (Hockley, Hemsworth, & Consoli, 1999), videos of environmental contexts (Smith, Handy, Angello, & Manzano, 2014), and pictures of scenes in the background (Gruppuso, Lindsay, & Masson, 2007; Hayes et al., 2010).

An important question not yet systematically investigated, is to what extent is a similarity between context at encoding and at retrieval needed for CE to emerge. Furthermore, in real-life situations, it is almost impossible to replicate at retrieval the exact contextual environment at encoding. Very few studies have addressed the question of context similarity between encoding and test.

Vakil, Hornik, and Levy (2008) presented pairs of words (e.g., Table – Dog) at the study, where one word is designated as target (Table – to be remembered) and one as context (Dog). At test, the target words were presented either with the original context word (Dog), or a conceptually similar (Cat), or perceptually similar (Fog), or new word (Apple). It was found that the conceptually similar words yielded CE to the same extent as the original context words, while target recognition did not benefit

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from the perceptually similar words any more than from the new words. Hockley (2008) in Experiment 4A was also interested in the effect of similarity of the old context on target recognition. In that study, words were presented against the background of a picture taken from one of six categories (e.g., buildings, public gardens). At test old words were presented either with the original picture, a similar picture (i.e., from the same category as the original which also shared physical similarity), and the new context. Results showed that context pictures, conceptually and physically similar to the original context, yielded the same CE as the original context picture. Notice that unlike the previous study by Vakil et al. (2008), the conceptual and physical similarity in this study is not dissociable. Smith et al. (2014) were also interested in the effect of conceptually similar context on target word retrieval. In Experiment 2, at encoding words were superimposed on short video clips showing a scene such as a restaurant. At test, participants were asked to recall as many words as possible when re-exposed either to the original video clips, video clips (scenes that are labelled similarly such as a restaurant) conceptually similar to that from learning, or no context. The results showed that although CE yielded by the conceptually similar video clips was less pronounced than that of the original clips, it was still significantly better than under no context. Hence, these studies demonstrated quite consistently that a context conceptually similar to the original context yields CE, whether tested by recall or recognition.

Several theoretical models have demonstrated that CE is not a unitary process, but rather is composed of at least two distinct cognitive processes linking Target and Context. Murnane, Phelps, and Malmberg (1999) in their Item, Context Ensemble – ICE theory, distinguished between *ensemble* and *familiarity*. Macken (2002) applied the distinction between *recollection* and *familiarity* to CE. In their multifactorial model of CE, Vakil et al. (2007) distinguished between *binding* and *familiarity*. In order to make this distinction, at least three CE testing conditions are required: I. Repeat, in which the exact context from encoding is reinstated at test with the original target; II. Re-pair or rearranged, in which an old context is presented at test with a target different than the original; And III. New context that was not presented at the encoding phase, or None (no context, i.e., pictures or words). The advantage of Repeat over the Re-pair condition would suggest a specific binding (or ensemble) between target and context, because both should have been familiar to the same extent. The advantage of Re-pair over New (or No) could not reflect binding, because Re-pair is not the original pair of Target-Context. However, it would reflect the familiarity effect, because of the presence of two old elements (old target and old context) versus only one (just old target), respectively.

The three studies reported above (Hockley, 2008; Smith et al., 2014; Vakil et al., 2008) showing the effect of a conceptually similar context on target recollection, did not include the Re-pair/rearrange condition at the test. As stated above, this omission prevented these studies from concluding which process (binding/ensemble or familiarity) was affected by the conceptually similar context.

Thus, to rectify this lack, the present study included the Re-pair condition to enable identification of the exact process affected by the conceptual similarity of context. In the present study, faces were the target stimuli to be remembered, and words (W) or pictures (P) of scenes served as context. In an attempt to test the effect of conceptual similarity on CE, four groups participated. Two groups were under the *consistent condition,* in which modality of context remained the same in the learning and testing phases (PP and WW). In addition, two groups were under the *inconsistent condition*, in which there was a change of modality between study and test (although the label remained the same): a word at learning (e.g., train station), and a picture of a train station at test (WP) and vice versa (PW). As explained in the Method section, the memory of faces was tested under Repeat, Re-pair, New and No context conditions. It was hypothesised that memory for faces in the consistent conditions (i.e., PP and WW) would replicate the same pattern of results found in a previous study (Vakil et al., 2007), in which modality between study and test remained constant: Repeat > Re-pair > New > No. This pattern of results was interpreted as reflecting both a binding process (based purely on conceptual processes) and familiarity processes (based on perceptual processes). Conversely, in the inconsistent conditions (i.e., PW and WP) in which modality is changed between study and test, since there is no perceptually similar context, familiarity is not expected to yield CE. Therefore, the pattern of results predicted was Repeat > Re-pair = New = No. This pattern of results was interpreted as reflecting a binding process based on conceptual processing that generated the CE.

Method

Participants

Participants were allocated randomly to one of four groups. The groups were formed initially based on the modality of context presented at the study phase, either pictures (P) or words (W). Then, each group was divided in half; *consistent condition* (same modality at test as in study, PP and WW) and *inconsistent condition*, where modality was changed at test (PW, WP) (see Appendix 1). That yielded four groups: pictures at study and at test (PP) ($n = 28$, mean age 22.41, age range 18-25), words at study and test (WW) ($n = 28$, mean age 21.75, age range 19-27), pictures at study, words at test (PW) ($n = 29$, mean age 23.42, age range 19-29) and words at study, pictures at test (WP) ($n = 29$, mean age 21.57, age range 18-25). Most of the participants were undergraduate students at Bar-Ilan University, who took part in the experiment to fulfil academic requirements. Sixteen participants received a coupon for coffee

and cake in return for their participation. Based on self-reports, none had histories of neurologic or psychiatric disorders. The study was approved, as required, by the Institutional Review Board of Bar-Ilan University. Informed consent was obtained from all participants.

Materials

Stimuli consisted of coloured photographs of male adult faces (i.e., Target, to be remembered information). These stimuli were randomly paired to form face-context pairs. The words were chosen based on a pretest in which participants were asked to name the scenes. Only scenes and words that had a very high naming agreement were chosen for the study. For the list of targets for all groups, we employed a local-context stimulus array of photographs of trial-unique male faces. The contexts were distinctive, trial-unique pictures of scenes in the PP and PW groups, and names of scenes (e.g., shopping centre) in the WP and WW groups. It is important to note that in the inconsistent condition when pictures of scenes at study changed to words (i.e., PW condition), the words described the original pictures. In other words, a picture of a shopping centre was replaced by the words "shopping centre" and vice versa for the WP condition (see Appendix 1).

The faces and their contexts were at a resolution of 1680×1050 pixels. All faces were photographed under the same light conditions and with neutral facial expressions. The photographs of faces were taken with permission of the authors from the XM2VTS database (Messer, Matas, Kittler, Luettin, & Maitre, 1999). The pictures of the scenes were downloaded from a free share website (https://www.lifeofpix.com/page/30/?display = small).

The faces and the background were randomly paired to form 64 face-context study pairs of either a picture of a scene (conditions PP & PW) or of a word (conditions WP & WW, see Appendix 1), and an additional 48 faces and 48 scenes supplemented them to form the various test pair combinations. Thus, all together we used 112 faces and 112 scenes in this study. Seven types of face-background picture pairs or face-only pictures were presented at test, each forming a different test condition (see Appendix 2):

(A) 8 of the originally studied pairs (Target Old, Context Old-Same; "Repeat" condition).
(B) 8 pairs in which a studied target face was presented in the context of a background that had been seen at study with a different face (Target Old, Context Old-Different "Re-pair" condition).
(C) 8 pairs in which a studied target face was presented in the context of a new background that had not been seen at study (Target Old, Context New [ToCn]; "New" condition).
(D) 8 studied target faces with no background (Target Old; "No" condition).
(E) 16 new unstudied faces presented in a background that had been seen at study with a different face (Target New, Context Old [TnCo]).
(F) 8 pairs of new, unstudied faces and backgrounds (Target New, Context New [TnCn]).
(G) 8 new unstudied faces with no background (Target New [Tn]).

Computer and software

Stimuli were presented on a 15.6″ laptop screen, with a monitor driven at a 60 Hz refresh rate and a resolution of 1366×768 pixels, using the E-prime 2.0 software, which controlled and recorded the temporal parameters of the stimulus display.

Procedure

At the encoding phase, face-background pairs were presented on a mobile computer screen by E-prime (2.0) software for 4000 milliseconds each. Between each pair, a cross was presented in the middle of the screen for 1000 milliseconds. Participants were instructed to remember the faces for a subsequent memory test. The learning phase was followed immediately by the test phase. Participants were told that they would see studied and unstudied faces. They were asked to indicate by key press ("L" key for an "old" response and "A" key for a "new" response), as quickly and accurately as possible, if the face had been seen at study (Old) or not (New), regardless of whether or not it was in the original context. Participants were verbally instructed to guess if unsure. They were then shown face-context pairs or face-only photos (types A-G above) in random order. The rate of presentation of test trials was self-paced, with the response triggering the following trial. All responses were automatically recorded by the E-prime software.

Results

Hit rate: Mixed ANOVA was conducted in order to test the effects of Context (Repeat, Re-pair, New, & No), Modality at the study phase (Pictures & Words), and Consistency (Consistent – modality remained the same at test as in study, Inconsistent – modality changed from study to test), the former is a within subjects factor and the latter two are between subjects factors. The results showed that both main effects, Context and Modality, reached significance, $F(3, 327) = 11.91$, $p < 0.001$, $\eta^2 = .01$ and $F(1, 109) = 4.62$, $p < 0.05$, $\eta^2 = .04$, respectively. However, the main effect for Consistency did not reach significance $F(1, 109) = 0.67$, $p = 0.42$, $\eta^2 = .01$. These main effects should be interpreted cautiously because of the significant Context by Modality and Context by Consistency interactions, $F(3, 327) = 3.35$, $p < 0.05$, $\eta^2 = .03$ and $F(3, 327) = 5.26$, $p < 0.01$, $\eta^2 = .05$, respectively.

In order to detect the source of the Context by Modality interaction, two post-hoc comparisons used the LSD procedure (for pictures and words separately). This analysis for pictures revealed that the source of context effect is Repeat > Re – pair > New = No. However, the source of the context effect with words is different, Repeat > Re- pair = New = No (see Figure 1(a)). Thus, beyond the Consistency effect, when faces were presented with pictures of scenes as context at the study phase, two components of CE emerge, binding (Repeat > Re-pair) as well as a familiarity component (Re-pair > New). However, when words were presented at study as context, just the binding component of CE emerged (Repeat > Re-pair).

In order to detect the source of the Context by Consistency interaction, two post-hoc comparisons used the LSD procedure (for consistent and inconsistent separately). This analysis for consistent condition revealed that the source of context effect is Repeat > Re-pair < New = No. As we had prior hypotheses about the inconsistent condition, we used a one-tailed test to check for statistical significance. As predicted, context effect (marginally significant $p < .06$) was driven by the binding effect (Repeat > Re-pair = New = No).

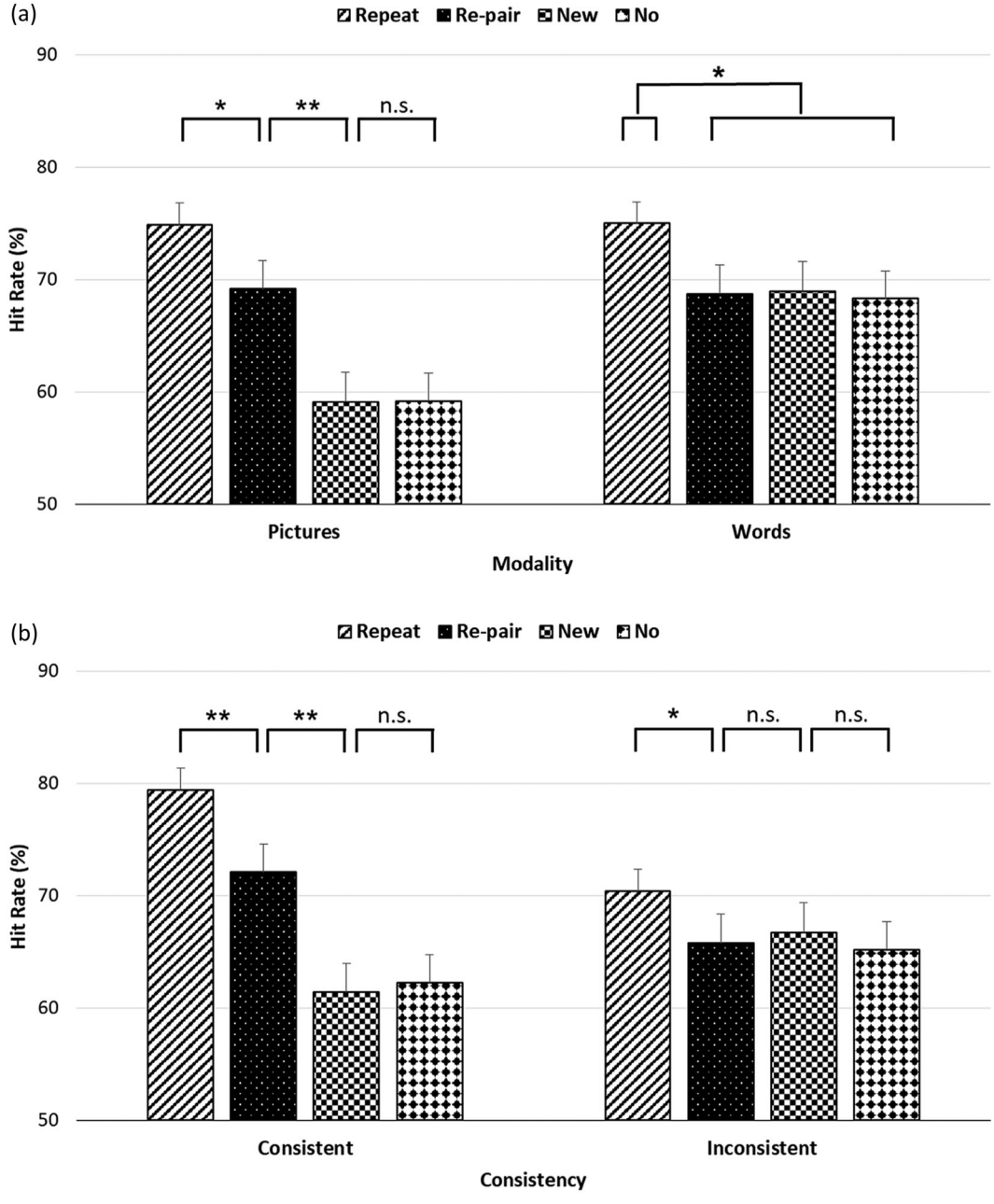

Figure 1. (a) Percent hit rate as a function of modality in the various context conditions. (b) Percent hit rate as a function of consistency in the various context conditions.

False alarms: Mixed ANOVA was conducted in order to test the effects of Context (TnCo, TnCn, & Tn), Modality at the study phase (Pictures & Words), and Consistency (Consistent & Inconsistent), the former is a within subjects factor and the latter two are between subjects factors. Context main effect was the only main effect that reached significance, $F(2, 218) = 13.55$, $p < 0.001$, $\eta^2 = .11$. Context by Modality, Context by Constituency and the triple interaction Context by Modality by Consistency all reached significance, $F(2, 218) = 4.20$, $p < 0.05$, $\eta^2 = .04$, $F(2, 218) = 3.36$, $p < 0.05$, $\eta^2 = .03$, and $F(2, 218) = 5.04$, $p < 0.01$, $\eta^2 = .04$, respectively.

In order to detect the source of the Context by Modality interaction, two post-hoc comparisons used the LSD procedure (for pictures and words separately). These analyses for pictures and words revealed that the source of context effect is TnCo > TnCn = Tn. However, it should be noticed that the effect was more pronounced for pictures ($p < .001$) than for words ($p < .05$) (see Figure 2(a)).

In order to detect the source of the Context by Consistency interaction, two post-hoc comparisons used the LSD procedure (for consistent and inconsistent separately). This analysis for consistent condition revealed that the source of context effect is TnCo > TnCn = Tn. However, the source of the context effect under the inconsistent condition was different, TnCo > Tn; TnCo = TnCn = Tn (see Figure 2(b)). The consistently higher FA rate observed

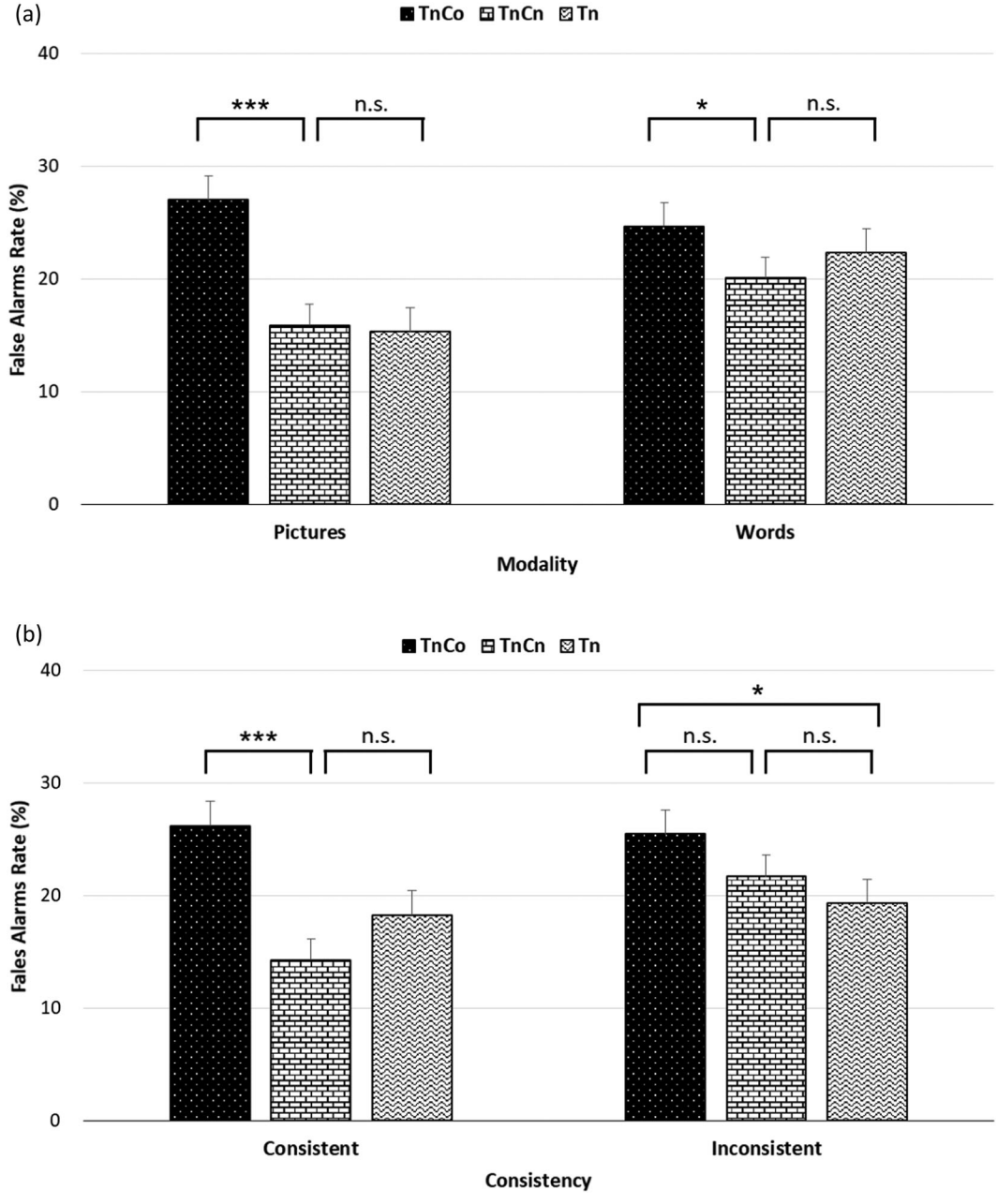

Figure 2. (a) Percent false alarms rate as a function of modality in the various context conditions. (b) Percent false alarms rate as a function of consistency in the various context conditions.

under the TnCo condition reflects a familiarity effect. In other words, the presence of an old context with a new target leads to a higher FA rate.

Discussion

The results demonstrated the importance of this study's attempt to include the Re-pair (rearrange) condition, in order to detect more precisely the source of the CE generated by a conceptually similar context. The first interesting finding was the effect of consistency on CE. In accordance with previous studies (Macken, 2002; Murnane et al., 1999; Vakil et al., 2007), when the context is held consistent (exact same stimuli) at the test as at learning, we saw both the effect of binding as well as the effect of familiarity. However, when modality was changed (from picture to a word with the same label or vice versa) the only process that generated CE was binding. These findings could be also viewed from the perspective of *the fluency heuristic in recognition memory* approach, according to which the ease of processing a stimulus at test affects the decision on a recognition test based on familiarity (Jacoby & Dallas, 1981). Westerman, Miller, and Lloyd (2003) found that fluency is used as a heuristic in recognition memory when modality remained constant between study and test phase. However, when pictures at the study phase were changed to words at the testing phase (Experiment 1) fluency had a minimal effect on recognition.

The significance of this finding is twofold. First, this study also confirmed findings of previous studies that conceptually similar context could generate CE (Hockley, 2008; Smith et al., 2014; Vakil et al., 2008). Second, the present study's paradigm, unlike previous ones, enabled us to detect the exact source of CE when presented with a context that is merely conceptually, but not perceptually similar to the original. Under such a context, CE is merely based on binding and much less on familiarity. This finding suggests that when modality was changed, there was almost no perceptual resemblance between the new and original context, so therefore, familiarity could not serve as a recognition cue. However, this conclusion should be taken cautiously for two reasons. First, it is based on a null result, and secondly as can be seen in Figure 2(b), the false alarm rates tended to be higher in a condition in which contexts were old not only under the consistent, but also under the inconsistent condition. This indicated that the familiarity process is involved even when modality from study to test is changed. In conclusion, any contribution of familiarity to CE under those circumstances is presumably small, and the most pronounced effect is binding, reflecting a conceptual process.

However, the semantic association between a face and context could serve as recognition cues even when modality is changed but the label remains constant. As argued by Hayes et al. (2010), the fact that CE could emerge under a context semantically or conceptually similar to the original allows more flexibility, because it does not require the exact reinstatement of the original context. The real-life implications of our results for modality change would be if you met a person in a restaurant and later met this person in a different place, he/she would not be easily remembered. However, should this person remind you that you met at a restaurant that ought to be a sufficient recognition cue to reinstate the CE. The opposite example would be, if a person tells you that he works at a train station, that would facilitate his recognition if you meet him at the train station.

The other interesting finding is that the pattern of CE is different as a function of modality at learning (collapsed over consistency). As can be seen in Figure 1(a), when pictures were presented, we see both binding effect (Repeat > Re-pair) as well as familiarity effect (Re-pair > New). However, when words are presented, we see the binding effect (Repeat > Re-pair) but no familiarity effect (Re-pair = New). This accords with Murnane et al. (1999), who stated that rich scenes are more effective in generating CE. Thus, old pictures, even when not in the original context, create a sense of familiarity. The CE produced by words, however, is merely due to the specific binding between the word and the face.

Another, although negative, expression of CE was the higher rate of FAs when a new face was presented with an old context (pictures or words), compared to a new or no context. Interestingly, under the consistent condition, more FAs were observed under the old context compared to new or no context. However, under the inconsistent condition, an old context generated more FAs than No context, but not more than a New context. Possibly, under the consistent condition, it is easier to make correct rejections of new faces when presented with a new context than in the inconsistent condition where the memory traces are weaker.

It is noteworthy that while CE in free and cued recall is generally robust, findings regarding CE on recognition have been widely divergent. Dalton (1993) showed that recognition CE emerged when unfamiliar faces were presented. Similarly, Russo, Ward, Geurts, and Scheres (1999) showed that the context reinstatement effect occurred for unfamiliar faces and non-words but not for words. That was the initial reason we used unfamiliar faces in this study as the target stimuli, to ensure the emergence of CE. Thus, generalisation of the present results would require further experiments with other types of stimuli as targets.

In conclusion, this study has offered some unique contributions to the literature on CE. It has demonstrated the importance of inclusion of the Re-pair condition in testing CE, in order to detect the sub-processes underlying the effect. More specifically, it enabled us to point to the binding process as the source of CE under a conceptually similar context.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendices

Appendix 1. An example of the stimuli presented at study and test for each of the four groups, PP, PW, WP, & WW (Words originally in Hebrew).

Appendix 2. An example (the PP group) of the stimuli presented at study and the seven conditions at test.