Effects of Conceptual Processing on Familiarity-based Recognition of Stimuli without Pre-existing Conceptual Representations

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Abstract

Two experiments compared the impact of conceptual and perceptual processing at encoding on the familiarity-based recognition of items without pre-existing conceptual representations. The stimuli for the experiments were visual designs and nonsense letter strings. The process dissociation procedure was used in conjunction with the process dissociation equations and the Dual Process Signal Detection model to assess the contributions of familiarity-based recognition and recollection in the recognition of the stimuli. A conceptual processing advantage was observed in both experiments: familiarity-based recognition was enhanced more by conceptual than by perceptual processing at encoding. It is suggested that the results may be problematic for the view that conceptual priming underlies the conceptual processing advantage.

Dual process theories of recognition generally distinguish two aspects of the phenomenon of recognition. First, an item may be experienced as *familiar* in a non-specific sense that is detached from context. For example, one may recognize a person's face, without remembering the circumstances of a previous encounter with that person. Second, an item may be *recollected* as having occurred previously in a certain context. For example, one may recognize a person's face and be able to remember the circumstances of a previous encounter with that person (see e.g., Jacoby, 1991; Mandler, 1991). Recognition on the basis of familiarity is of particular interest because it seems to inhabit a gray area between explicit memory, in which past experience is consciously remembered, and implicit memory, in which past experience affects present behavior, in the absence of conscious awareness.

Students of memory have sought to characterize familiarity-based recognition in terms of the encoding and retrieval processing that it reflects. They have sought to do this in terms of a distinction that has been drawn in other work between forms of processing that emphasize, respectively, the *perceptual* and *conceptual* features of an item (Roediger, Weldon, & Challis, 1989). In early conceptions, familiarity-based recognition was seen as reflecting perceptual processing (Mandler, 1980). More recently, however, this aspect of recognition has been shown to reflect conceptual as well as perceptual processing. Conceptual processing has been shown to exert an effect in particular at the time of encoding. Various forms of conceptual processing (rating the pleasantness of the meaning of words, solving anagrams) have been shown to enhance familiarity-based recognition more than do various forms of perceptual

processing (rating the difficulty of generating rhymes to words, reading words), (Jacoby, 1991; Toth, 1996; Verfaellie & Treadwell, 1993; Wagner, Gabrieli, & Verfaellie, 1997).

Why does conceptual processing at encoding enhance familiarity-based recognition more than perceptual processing does? One influential account of this *conceptual processing advantage* appeals to a process of *conceptual priming*. Conceptual priming is the potentiation of a concept consequent to prior processing. For example, after reading the words *guard* and *dog* in succession, participants may be more likely than in a baseline condition to produce *dog* as an associate of *guard* (Ramponi, Richardson-Klavehn, & Gardiner, 2007). A hypothetical process of conceptual priming is used as follows to account for the conceptual processing advantage. During the learning phase, a conceptual representation is more likely to be evoked for an item if the item is processed at the conceptual than the perceptual level. Subsequent processing of that conceptual representation is facilitated if the representation was evoked at encoding. Familiarity-based recognition of the item is more likely if processing of the item's conceptual representation is facilitated. The increased likelihood of familiarity-based recognition reflects a process of attribution - the facility with which the representation is processed is taken as evidence that the item is familiar (Rajaram & Geraci, 2000; Toth, 1996; Wagner et al., 1997).

This *conceptual priming hypothesis* was developed to explain the conceptual processing advantage for stimuli with pre-existing conceptual representations. In fact, to our knowledge, all of the studies demonstrating the conceptual processing advantage have used such stimuli. In the present study, we sought to challenge the hypothesis by showing that the conceptual processing advantage can occur for stimuli without pre-

existing conceptual representations. In our first experiment, the stimuli were novel visual designs. In our second experiment, the stimuli were nonsense letter strings. The primary independent variable in both experiments was the type of processing induced during the learning phase; participants were induced to process the items either conceptually or perceptually. In both experiments, we showed a higher level of familiarity-based recognition with conceptual processing than with perceptual processing. These results may require a re-thinking of the conceptual priming hypothesis. As we demonstrate later, the hypothesis can only accommodate them if it allows the attribution of familiarity consequent to facilitation in the processing, not only of an item's conceptual representation but also of a conceptual representation to which an item is linked.

To dissociate familiarity-based recognition from recollection in this project we used the process dissociation (PD) methodology (Jacoby, 1991). In this methodology, two distinct classes of items are presented during the learning phase of a memory task and two distinct procedures are used to assess recognition during the test phase of the task. In the inclusion procedure, participants are instructed to emit positive responses to both classes of items. In the exclusion procedure, participants are instructed to emit positive responses to items in only one class. Interest focuses on the class of items that is supposed to be excluded under the exclusion procedure. This is the *critical* class of items, for which estimates of familiarity-based recognition and recollection are to be derived. The presumption is that, in judgments to the items in this class, familiarity-based recognition and recollection cooperate in the inclusion procedure and oppose one another in the exclusion procedure.

To estimate familiarity-based recognition and recollection, we used the original PD equations (Jacoby, 1991) and the Dual Process Signal Detection (DPSD) model (Jacoby, Toth, & Yonelinas, 1993; Yonelinas, 1994; Yonelinas, Regehr, & Jacoby, 1995). The PD equations presume that participants make positive responses under the inclusion procedure on the basis of either familiarity-based recognition or recollection, that participants make positive responses under the exclusion procedure only if they register the test item as familiar but fail to recollect it, that familiarity-based recognition and recollection are independent processes, and that the two processes operate in the same way under the inclusion and exclusion procedures (Jacoby, 1998). Given these assumptions, the equations derive indices of familiarity-based recognition and recollection directly from the data obtained with the inclusion and exclusion procedures:

$$F = POE/(1-R) \qquad R = POI - POE$$

where F and R are the probabilities of familiarity-based recognition and recollection, respectively, and POE and POI are the probabilities of making a positive response to an old item of the critical class under the exclusion and inclusion procedures, respectively.

The PD equations do not give accurate estimates of the probabilities of familiarity-based recognition and recollection when the probabilities of positive response to new, unstudied items differ across experimental conditions. When this is the case, response bias differs across the conditions, and accurate measurement of the crucial probabilities is thereby impeded (Yonelinas & Jacoby, 1996). One can, however, achieve accurate estimates of familiarity-based recognition and recollection in this case with the Dual Process Signal Detection model. In addition to the assumptions of the original PD equations, this model assumes that familiarity-based recognition reflects an

equal variance signal detection process and that recollection reflects a threshold process, such that the context information retrieved for a given item either does or does not exceed the threshold for recollection (Parks & Yonelinas, 2007). Under the further assumption that the distributions for the familiarity-based process are Gaussian in form, the probability of making a positive response to an old item of the critical class under the inclusion procedure is:

(Equation 1) $POI = \Phi(d'/2 - C_I) + R - \Phi(d'/2 - C_I)\, R$

where $\Phi(d'/2 - C_I)$ is the probability that the item exceeds the familiarity-based response criterion under the inclusion procedure. The probability of making a positive response to an old item of the critical class under the exclusion procedure is:

(Equation 2) $POE = \Phi(d'/2 - C_E) - \Phi(d'/2 - C_E)\, R$

where $\Phi(d'/2 - C_E)$ is the probability that the item exceeds the familiarity-based response criterion under the exclusion procedure. The probability of making a positive response to a new item under the inclusion procedure is:

(Equation 3) $PNI = \Phi(-d'/2 - C_I)$

and the probability of making a positive response to a new item under the exclusion procedure is: (Equation 4) $PNE = \Phi(-d'/2 - C_E)$

where $\Phi(-d'/2 - C_I)$ and $\Phi(-d'/2 - C_E)$ are the probabilities that a new item exceeds the familiarity-based response criterion under the inclusion and exclusion procedures, respectively. On the basis of recognition performance under the inclusion and exclusion procedures and these four equations, the DPSD model estimates the probabilities of familiarity-based recognition and recollection for a given experimental condition.

In sum, we sought to show that, for stimuli without pre-existing conceptual representations, the probability of familiarity-based recognition can be greater with conceptual than with perceptual processing at encoding. Because our stimuli were novel and therefore presumably somewhat difficult to remember, we compared the two forms of processing at two levels of presentation frequency, presenting items either once or five times during the learning phase. We reasoned that, whereas memory for items presented only once might not be stable enough to allow reliable measurement of familiarity-based recognition and recollection, memory for items presented five times should be stable enough to allow this. Thus, we were assured of obtaining useful data for items presented five times and, in the event that a single presentation was sufficient, we were in a position to obtain twice as many data points with only a small additional expenditure of resources.

Experiment 1

The broad outlines of the experiment were as follows. During the learning phase, participants studied two lists of designs, hereafter List 1 and List 2. Each design in the two lists was presented either once or five times. Participants were induced to process the designs in one of the lists conceptually and to process the designs in the other list perceptually. During the test phase, participants were presented two lists of designs, hereafter List A and List B, each of which consisted of designs from List 1, designs from List 2, and new designs. Participants responded to one of the test lists under the inclusion procedure and the other test list under the exclusion procedure. List 1 constituted the critical class. Using the PD equations and the DPSD model, the experiment sought to estimate the probabilities of familiarity-based recognition and

recollection for the designs in List 1 under the four conditions that occurred when the two levels of processing type and the two levels of presentation frequency were crossed.

Method

Participants. Fifty-six undergraduate students participated to fulfill a requirement for a lower-level psychology class at the George Washington University.

Design. A 2 x 2 x 2 mixed design was used. Processing Type (Conceptual/ Perceptual) was manipulated between participants. Test Type (Inclusion/Exclusion) and Presentation Frequency (Once/Five Times) were manipulated within participants. The order of administration for the Conceptual and Perceptual conditions and the Inclusion and Exclusion conditions was counterbalanced as follows. Each participant was randomly assigned to one of four groups. Participants in groups I and II processed the List 1 designs in the Conceptual condition and the List 2 designs in the Perceptual condition. Participants in groups III and IV processed the List 1 designs in the Perceptual condition and the List 2 designs in the Conceptual condition. Participants in Groups I and III responded to the List A designs in the Inclusion condition and the List B designs in the Exclusion condition. Participants in groups II and IV responded to the List A designs in the Exclusion condition and the List B designs in the Inclusion condition. Notice that, although all participants processed designs in both the Conceptual and the Perceptual conditions during the learning phase, only the participants in Groups I and II processed the critical List 1 designs in the Conceptual condition and only the participants in Groups III and IV processed the List 1 designs in the Perceptual condition. Thus, one effect of this counterbalancing scheme was to create participant

groups corresponding to the Conceptual and Perceptual conditions. The other effect of the scheme was to counterbalance the order of administration for the Inclusion and Exclusion conditions. The design is diagrammed in Figure 1.

Insert Figure 1 about here

Materials.

Each of the 145 stimuli was a design involving a complex, novel, arrangement of symmetric and asymmetric geometric figures, and measuring approximately 11 cm x 13 cm. A sample design is shown in Figure 2. During the learning phase, List 1 was a series of 120 designs in which 20 designs appeared once and another 20 designs appeared five times apiece; List 2 was a series of 96 designs in which 16 designs appeared once and another 16 designs appeared five times apiece. The order of the designs in the two lists, and the interval between successive occurrences of the same design in the Five Times condition, was randomly-determined. List 1 was longer than List 2 because the designs in List 1 constituted the critical class, for which estimates of familiarity-based recognition and recollection were to be derived. During the test phase, List A and List B was each a series of 72 designs - 10 designs randomly selected from the group presented once in List 1, 10 designs randomly selected from the group presented five times in List 1, 8 designs randomly selected from the group presented once in List 2, 8 designs randomly selected from the group presented five times in List 2, and 36 new designs. For a given participant, the particular designs that were presented at the different levels of frequency in Lists 1 and 2, and as new designs in Lists A and B, were randomly sampled from the pool of 145 designs. The order of the designs in the two test lists was randomly-determined.

Insert Figure 2 about here.

Procedure.

Participants were seated at individual computer stations. They were informed that they would be presented with a series of designs, that they would have to perform various tasks with respect to the designs, and that, afterward, they would be given a memory test for the designs.

Learning phase. The learning phase consisted of a series of trials, on each of which a design was presented for seven seconds while the participant performed a cognitive task with respect to it. In the Conceptual condition, participants performed two different conceptual tasks, in separate blocks of trials. In the first task, participants indicated whether each design was related to a living organism, a non-living man-made object, a combination of organism and man-made object, or something else. In the second task, participants assigned a verbal label/name to each design and indicated whether their label contained 1, 2, 3, or more words. In the Perceptual condition, participants performed two different perceptual tasks, in separate blocks of trials. In the first task, participants judged the symmetry of each design. In the second task, participants counted the number of four-vertex diamond shapes in each design. Half of the learning trials occurred in each block of the learning phase. In the Five Times condition, designs were presented either 2 or 3 times in each block. Two different tasks were used in each Processing Type condition to keep participants interested and to minimize the possibility that participants would use their own techniques for processing the designs. Between the presentation of Lists 1 and 2, participants performed a word discrimination task, the purpose of which was to differentiate the two lists.

We did not record performance on the conceptual and perceptual tasks in our original experiment, but did so in a follow-up experiment involving 10 participants. In the conceptual tasks, participants were fairly consistent in the objects and the labels that they assigned across successive encounters with the same design in the Five Times condition (average percent repeated responses: 77). In the perceptual tasks, participants were quite accurate in judging symmetry (average percent correct: 93) and somewhat less accurate in counting the diamond shapes (average percent correct: .84). In general, participants completed the required tasks in less than the seven seconds for which the designs were exposed (average response time: 3,251 ms). By implication, participants may have engaged in some perceptual processing in the Conceptual condition and some conceptual processing in the Perceptual condition. The primary effect of any such impurity would have been to reduce the differences that were observed as a function of processing type. Participants were faster to make their responses in the Conceptual (average response time: 3,528 ms) than the Perceptual (average response time: 2,974 ms) condition [$F(1,9)$ = 9,93, MSe = 102,655]. By implication, participants spent less time in conceptual than perceptual processing. Given that the objective in the study was to show better memory after performance of conceptual than perceptual processing, this inequity may have reduced the differences that were observed as a function of processing type.

Test Phase. In the Inclusion condition, participants were instructed to emit positive responses to List 1 and List 2 designs. In the Exclusion condition, participants were instructed to emit positive responses only to List 2 designs. Accuracy rather than speed was emphasized. Each test design remained on the screen for a maximum of

fifteen seconds or until a response was emitted. Responses occurring after fifteen seconds had elapsed were recorded as omissions. After a response was made, a pause screen appeared, allowing participants to proceed when ready. A short break, approximately one minute in length, occurred at the beginning of each part of the test phase, during which the participant read the instructions for that part.

Results and discussion

The probability of a positive response to an old design from List 1 (PO) was calculated for each condition and each participant (See Table 1). PO was greater in the Conceptual than in the Perceptual condition [$F(1,52) = 24.12$, $MSe = .061$], greater in the Five Times than in the Once condition [$F(1,52) = 86.58$, $MSe = .072$], and greater in the Inclusion than in the Exclusion condition [$F(1,52) = 35.66$, $MSe = .063$]. The effects of Presentation Frequency and Test Type interacted in the PO data [$F(1,52) = 12.40$, $MSe = .035$], with the effect of Presentation Frequency being greater in the Inclusion than in the Exclusion condition. Neither the effects of Processing Type and Presentation Frequency [$F(1,52) = 3.05$, $MSe = .072$] nor the effects of Processing Type and Test Type interacted in the PO data [$F(1,52) < 1$]. Finally, the effects of Processing Type, Presentation Frequency, and Test Type interacted in these data [$F(1,52) = 6.02$, $MSe = .035$].

To clarify the nature of the latter interaction, the data for the Inclusion and Exclusion conditions were examined separately. In the Inclusion condition, PO was greater in the Conceptual than in the Perceptual condition [$F(1,52) = 32.51$, $MSe = .044$] and greater in the Five Times than in the Once condition [$F(1,52) = 45.89$, $MSe = .051$]. The effects of Processing Type and Presentation Frequency did not interact in the PO

data for the Inclusion condition [$F(1,52)$ = 2.09, MSe = .051]. In the Exclusion condition, PO was greater in the Five Times than in the Once condition [$F(1,52)$ = 7.37, MSe = .047] and fell somewhat short of being greater in the Conceptual than in the Perceptual condition [$F(1,52)$ = 3.09, MSe = .090, p = .085]. The effects of Processing Type and Presentation Frequency did not interact in the PO data for the Exclusion condition [$F(1,52)$ = 2.24, MSe = .047].

Insert Table 1 about here

The probability of a positive response to a new design (PN) was also calculated for each relevant condition (PN was not relevant for the Once and Five Times conditions; PN indexes response bias, and the same response bias was presumably in force in the Once and Five Times conditions) and each participant (See Table 2). PN did not vary as a function of Processing Type [$F(1,52)$ = 2.03, MSe = .066] or Test Type [$F(1,52)$ = 1.29, MSe = .023]. The effects of Processing Type and Test Type did not interact in the PN data [$F(1,52) < 1$].

Insert Table 2 about here

The object of the experiment was to estimate the probabilities of familiarity-based recognition and recollection for the four conditions that occurred when the levels of Processing Type and Presentation Frequency were crossed. From the fact that PN did not vary with Processing Type, we inferred that response bias did not vary with Processing Type. Given this fact, and in light of prior work indicating that, even if response bias had varied with Processing Type, this variation would not have changed the relative level of performance in the two Processing Type conditions (Snodgrass & Corwin, 1988), we estimated the probabilities of familiarity-based recognition and

recollection using the PD equations (Yonelinas et al., 1995). The equations derive these probabilities from POI and POE, as were defined earlier. To avoid undefined values in these and later calculations, it was necessary, before applying the equations, to adjust for limit situations in which the participant correctly recognized all or none of the designs that fell into a given cell of the analysis. Therefore, a transformation, recommended by Snodgrass and Corwin (1988), was applied. POI was transformed to POI', which was defined as follows:

(Equation 5) POI' = (NOI + 0.5/ NI +1),

where NOI is the number of positive responses to List 1 designs in the Inclusion condition, and NI is the number of List 1 designs in the Inclusion condition. POE was transformed to POE', which was defined as follows:

(Equation 6) POE' = (NOE + 0.5/ NE +1),

where NOE is the number of positive responses to List 1 designs in the Exclusion condition, and NE is the number of List 1 designs in the Exclusion condition.

As Table 3 shows, the estimated probability of familiarity-based recognition was greater in the Conceptual condition than in the Perceptual condition [$F(1,52) = 15.98$, $MSe = .083$] and greater in the Five Times than in the Once condition [$F(1,52) = 37.95$, $MSe = .073$]. The effects of Processing Type and Presentation Frequency did not interact in the familiarity data [$F(1,52) < 1$]. The estimated probability of recollection was greater in the Five Times than in the Once condition [$F(1,52) = 12.40$, $MSe = .071$], and fell somewhat short of being greater in the Conceptual condition than in the Perceptual condition [$F(1,52) = 3.05$, $MSe = .144$, $p = .09$]. The effects of Processing Type and Presentation Frequency interacted in the recollection data [$F(1,52) = 6.02$, $MSe = .071$].

In the Once condition, the estimated probability of recollection was greater in the Conceptual than in the Perceptual condition [$F(1,52)$ = 10.38, MSe = .083]. In the Five Times condition, the estimated probability of recollection did not differ in the Conceptual and Perceptual conditions [$F(1,52) < 1$].

Insert Table 3 about here

To reinforce our conclusions, we also estimated the probabilities of familiarity-based recognition and recollection with the DPSD model. This model derives these probabilities from POI, POE, PNI, and PNE, as were defined earlier. POI and POE were transformed into POI' and POE' in the manner indicated earlier and PNI and PNE were transformed as follows:

(Equation 7) PNI' = (NNI + 0.5/ NI +1),

where NNI is the number of positive responses to new designs in the Inclusion condition, and NI is the number of new designs in the Inclusion condition.

(Equation 8) PNE' = (NNE + 0.5/ NE +1),

where NNE is the number of positive responses to new designs in the Exclusion condition, and NE is the number of new designs in the Exclusion condition.

To facilitate application of the DPSD model, the logistic rather than the Gaussian distribution was assumed in the familiarity component, as has been recommended by Yonelinas and Jacoby (1996). With this change, it was possible to obtain estimates of familiarity-based recognition and recollection from a closed-form solution of the model as opposed to a search procedure. Snodgrass and Corwin (1988) showed that the logistic and Gaussian distributions produce equivalent results when applied to a wide range of recognition data. Yonelinas and Jacoby (1996) found little difference in

estimates of familiarity-based recognition and recollection based on the two distributions. Appendix A shows how, given the assumption of logistic distributions, the DPSD model derives the probabilities of familiarity-based recognition and recollection from POI', POE', PNI', and PNE' (notice that the performance of the familiarity component is expressed as a probability of familiarity-based recognition rather than as a value of *d'*) (Yonelinas & Jacoby, 1996; Yonelinas et al., 1995). As Table 4 shows, the estimated probability of familiarity-based recognition was greater in the Conceptual condition than in the Perceptual condition [$F(1,52) = 21.50$, $MSe = .054$] and greater in the Five Times than in the Once condition [$F(1,52) = 39.89$, $MSe = .056$]. The effects of Processing Type and Presentation Frequency did not interact in the familiarity data [$F(1,52) < 1$]. The estimated probability of recollection was greater in the Five Times than in the Once condition [$F(1,52) = 15.25$, $MSe = .048$], and fell somewhat short of being greater in the Conceptual condition than in the Perceptual condition [$F(1,52) = 2.72$, $MSe = .108$, $p = .11$]. The effects of Processing Type and Presentation Frequency did not interact in the recollection data [$F(1,52) = 3.99$, $MSe = .048$].

Insert Table 4 about here

Although the stimuli for this experiment did not have pre-existing conceptual representations, conceptual processing enhanced familiarity-based recognition of these stimuli more than perceptual processing did. Experiment 2 sought to reinforce these results.

Experiment 2

Experiment 2 resembled Experiment 1 except in the following respects: 1) the stimuli were nonsense letter strings rather than visual designs. 2) Processing Type was

manipulated within rather than between participants. 3) Only a single conceptual and a single perceptual encoding task were used.

The experiment was composed of two parts, each of which consisted of a learning phase and a test phase. During the learning phase of each part, participants studied two lists of letter strings, hereafter List 1 and List 2. Each string in the two lists of each part was presented either once or five times. Each participant was induced to process the strings in each of the lists conceptually in one part of the experiment and perceptually in the other part. During the test phase of each part, participants were presented two lists of strings, hereafter List A and List B, each of which consisted of strings from List 1, strings from List 2, and new strings. Each participant responded to one of the test lists in each part under the inclusion procedure and the other test list in that part under the exclusion procedure. List 1 constituted the critical class. Using the PD equations and the DPSD model, the experiment sought to estimate the probabilities of familiarity-based recognition and recollection for the strings in List 1 under the four conditions that occurred when the two levels of processing type and the two levels of presentation frequency were crossed.

Method

Participants. Forty undergraduate students were recruited from the same population as was used in Experiment 1.

Design. A 2 x 2 x 2 design was employed, with Processing Type (Conceptual/ Perceptual), Test Type (Inclusion/Exclusion), and Presentation Frequency (Once/Five Times) all being manipulated within participants. The order of administration for the Conceptual and Perceptual conditions and the Inclusion and Exclusion conditions was

counterbalanced as follows. Each participant was randomly assigned to one of four groups. In part 1, participants in groups I and II processed the List 1 strings in the Conceptual condition and the List 2 strings in the Perceptual condition; in part 2, the assignment of lists to processing conditions was reversed. In part 1, participants in groups III and IV processed the List 1 strings in the Perceptual condition and the List 2 strings in the Conceptual condition; in part 2, the assignment of lists to processing conditions was reversed. In both parts of the experiment, participants in Groups I and III responded to the List A strings in the Inclusion condition and the List B strings in the Exclusion condition whereas participants in groups II and IV had the opposite assignment of lists to processing conditions. Notice that, over the course of the experiment, all participants processed List 1 strings in both the Conceptual and the Perceptual conditions.

Materials.

Each of the 160 stimuli was a string of from four to eight letters. During the learning phase of each part, List 1 and List 2 was each a series of 60 strings in which 10 strings appeared once and another 10 strings appeared five times apiece. During the test phase of each part, List A and List B was each a series of 40 strings – 5 strings randomly selected from the group presented once in List 1, 5 strings randomly selected from the group presented five times in List 1, 5 strings randomly selected from the group presented once in List 2, 5 strings randomly selected from the group presented five times in List 2, and 20 new strings. The particular strings that were presented to a given participant at the different levels of frequency in Lists 1 and 2 of each part, and as new

strings in Lists A and B of each part, were randomly sampled from the pool of 160 strings. The order of the strings in the learning and test lists was randomly-determined.

Procedure.

Participants were seated at individual computer stations. They were informed that they would be presented several series of letter strings, that they would have to perform various tasks with respect to the strings, and that, afterward, their memory for the strings would be tested.

Learning phase. The learning phase consisted of a series of trials, on each of which a letter string was presented for two seconds while the participant performed a cognitive task with respect to it. In the Conceptual condition, participants indicated whether they thought of an action, an object, or a concept when seeing each letter string. In the Perceptual condition, participants indicated whether each letter string contained more vowels or consonants. Only one conceptual and one perceptual task were used a) to facilitate timely completion of the experiment, which was longer than Experiment 1 because all of the independent variables were manipulated within participants, and b) because the need for task variety was less given that the lists were shorter.

Test Phase. The procedure for the test phase was the same as for Experiment 1.

Results and discussion

Table 5 summarizes the PO data for the experiment. PO was greater in the Conceptual than in the Perceptual condition [$F(1,36)$ = 8.38, MSe = .077], greater in the Five Times than in the Once condition [$F(1,36)$ = 72.07, MSe = .037], and greater in the Inclusion than in the Exclusion condition [$F(1,36)$ = 56.58, MSe = .103]. The effects of

Processing Type and Test Type interacted in the PO data [$F(1,36)$ = 5.62, MSe = .060], with the effect of Processing Type being greater in the Inclusion than in the Exclusion condition. Neither the effects of Processing Type and Presentation Frequency [$F(1,36) < 1$] nor the effects of Presentation Frequency and Test Type [$F(1,36)$ = 3.19, MSe = .056] interacted in the PO data. Finally, the effects of Processing Type, Presentation Frequency, and Test Type interacted in these data [$F(1,36)$ = 5.13, MSe = .030].

To clarify the nature of the latter interaction, the data for the Inclusion and Exclusion conditions were examined separately. In the Inclusion condition, PO was greater in the Conceptual than in the Perceptual condition [$F(1,36)$ = 19.91, MSe = .048] and greater in the Five Times than in the Once condition [$F(1,36)$ = 45.07, MSe = .047]. The effects of Processing Type and Presentation Frequency did not interact in the PO data for the Inclusion condition [$F(1,36) < 1$]. In the Exclusion condition, PO was greater in the Five Times than in the Once condition [$F(1,36)$ = 15.66, MSe = .046] but did not vary as a function of Processing Type [$F(1,36) < 1$]. The effects of Processing Type and Presentation Frequency did not interact in the PO data for the Exclusion condition [$F(1,36)$ = 2.81, MSe = .051].

Insert Table 5 about here

Table 6 summarizes the PN data for the experiment. PN was greater in the Inclusion than in the Exclusion condition [$F(1,36)$ = 8.09, MSe = .020] but PN did not vary as a function of Processing Type [$F(1,36) < 1$]. The effects of Test Type and Processing Type did not interact in the PN data [$F(1,36)$ = 1.03, MSe = .011].

Insert Table 6 about here

Because PN did not vary as a function of Processing Type, we were again able to estimate the probabilities of familiarity-based recognition and recollection using the PD equations. As can be seen in Table 7, the estimated probability of familiarity-based recognition was greater in the Conceptual condition than in the Perceptual condition [$F(1,36)$ = 10.69, MSe = .041] and greater in the Five Times than in the Once condition [$F(1,36)$ = 61.82, MSe = .028]. The effects of Processing Type and Presentation Frequency did not interact in the familiarity data [$F(1,36) < 1$]. The estimated probability of recollection was greater in the Five Times condition than in the Once condition [$F(1,36)$ = 4.36, MSe = .074] and fell somewhat short of being greater in the Conceptual condition than in the Perceptual condition [$F(1,36)$ = 3.18, MSe = .092, p = .083]. The effects of Processing Type and Presentation Frequency interacted in the recollection data [$F(1,36)$ = 4.79, MSe = .041]. Whereas the Conceptual and Perceptual conditions differed in the Five Times condition, $F(1,36)$ = 6.16, MSe = .077, the two conditions did not differ in the Once condition, $F(1,36) < 1$.

Insert Table 7 about here

To reinforce our conclusions, we estimated the probabilities of familiarity-based recognition and recollection with the DPSD model, using the same transformations and calculations as for Experiment 1. As can be seen in Table 8, the estimated probability of familiarity-based recognition was greater in the Conceptual condition than in the Perceptual condition [$F(1,36)$ = 10.86, MSe = .041] and greater in the Five Times than in the Once condition [$F(1,36)$ = 62.32, MSe = .026]. The effects of Processing Type and Presentation Frequency did not interact in the familiarity data [$F(1,36) < 1$]. The estimated probability of recollection was greater in the Conceptual condition than in the

Perceptual condition [$F(1,36)$ = 10.43, MSe = .049] and greater in the Five Times condition than in the Once condition [$F(1,36)$ = 8.55, MSe = .032]. The effects of Processing Type and Presentation Frequency did not interact in the recollection data [$F(1,36)$ = 1.97, MSe = .030]

Insert Table 8 about here

Although the stimuli for the experiment did not have pre-existing conceptual representations, conceptual processing again enhanced familiarity-based recognition of these stimuli more than perceptual processing did.

General Discussion

The most important results are the effects of conceptual and perceptual processing on the probability of familiarity-based recognition. The same general pattern was observed in both experiments. Familiarity-based recognition was more likely after conceptual than after perceptual processing. Thus, the conceptual processing advantage occurred for stimuli that did not have pre-existing conceptual representations. This result testifies to the generality of the phenomenon, extending earlier work using stimuli with pre-existing conceptual representations (Jacoby, 1991; Toth, 1996; Verfaellie & Treadwell, 1993; Wagner, et al. 1997).

Can the conceptual priming hypothesis accommodate these results? Recall that the hypothesis would explain the results as follows: A conceptual representation was more likely to be evoked for a to-be-remembered item if the item was processed at the conceptual than the perceptual level. Subsequent processing of the item's conceptual representation was facilitated if the representation was evoked at encoding. Facilitation in the processing of the item's conceptual representation was taken, at the point of test,

as evidence that the item was familiar (Rajaram & Geraci, 2000; Toth, 1996; Wagner et al., 1997).

To determine whether this explanation will work, we need to formulate it in terms of a well-specified model of priming. Given the nature of the question at issue, our priming model must accommodate the distinction between items with and without pre-existing conceptual representations. Bower (1996) has proposed a priming model that fulfills these requirements. In the Bower model, knowledge is represented in terms of a semantic network, with knowledge elements being represented as nodes and relationships between knowledge elements being represented as links. Type-1 links represent relationships between the elements that comprise world knowledge and relationships between the perceptual features of novel stimuli. Type-2 links represent associations between distinct and previously unassociated knowledge elements. For example, an association between the words “dog” and “umbrella” would be represented with a Type – 2 link. When an item with pre-existing perceptual and conceptual representations is processed perceptually, the nodes for the perceptual features of the item and the node for the item itself are activated. New Type-1 links may be encoded between these nodes. Residual activation in these nodes and the existence of newly encoded Type-1 links may facilitate subsequent processing of the item, thereby producing perceptual priming. When an item with pre-existing perceptual and conceptual representations is processed conceptually, the nodes for the conceptual features of the item and the node for the item itself are activated. New Type-1 links may be encoded between these nodes. Residual activation in these nodes and the existence of newly encoded Type-1 links may facilitate subsequent processing of the item, thereby

producing conceptual priming. When a novel item is processed, the nodes for the perceptual features of the item and a node for the item itself are activated. New Type-1 links may be encoded between these nodes. Residual activation in these nodes and the existence of the newly encoded Type-1 links may facilitate subsequent processing of the item, thereby producing perceptual priming.

Consider, then, how the Bower (1996) model would construe what happened in our experiments. Each time an item was presented during the learning phase, the nodes for the perceptual features of the item and the node for the item itself would have been activated and new Type-1 links may have been encoded between these nodes. When the item was presented during the test phase, its processing would have been facilitated to the extent the nodes for the item and its perceptual features were residually active and to the extent that newly encoded Type-1 links were present. This was presumably the basis of the advantage that was observed in the familiarity data for the Five Times as opposed to the Once condition.

When an item was processed perceptually during the learning phase, activation of the nodes for the perceptual features of the item and encoding of new Type-1 links may have increased. When the item was presented during the test phase, the facilitation of processing may have increased accordingly, and familiarity-based recognition of the item may have been more likely. Thus, perceptual priming may have occurred, such as has previously been observed for novel visual stimuli (Schacter, Cooper, Delaney, Peterson, & Tharan, 1991) (We cannot say whether perceptual processing had this effect because the study lacked the necessary control conditions).

When an item was processed conceptually during the learning phase, the node for the word or concept with which the item was linked in that processing would have been activated. In addition, a Type-2 link may have been encoded between the node for the item and the node for that word or concept. The link in question would have been a Type-2 link because it represented a new association between previously unassociated knowledge elements. During the test phase, the word or concept with which the item was linked would have been more accessible because its node was activated. In addition, the Type-2 link between the node for the item and the node for that word or concept may have facilitated explicit retrieval, depending on how the retrieval process is construed, because the link may have increased the number of paths between the item node and the context node. The link would not have facilitated processing of the item's conceptual representation, however, because such a representation did not exist. In fact, the link would not have facilitated processing of any aspect of the item's representation. Thus, processing facilitation could not have been taken as evidence that the item was familiar.

If priming operates according to the Bower (1996) model, and if the conceptual priming hypothesis is formulated as in past work, then the hypothesis cannot easily explain the present results. Intuitively, the problem is that processing of the conceptual representation for the to-be-remembered item cannot be facilitated because the representation doesn't exist as an independent component of the item's memory record. Of course, the present results may be explicable in terms of the conceptual priming hypothesis in conjunction with a different model of priming. We have so far not been able to locate such a model, however. Alternatively, the results may be explicable in

terms of a modified version of the conceptual priming hypothesis. For example, we might be able to construct an explanation in which 1) items that were processed conceptually during the learning phase were linked in memory to the concepts with which they were processed, and 2) items were taken to be familiar during the test phase on the basis of the fact that they were linked with concepts that were active in memory. Although such an explanation might provide a post-hoc explanation of our results, its viability would need to be tested in further work. Notice also that such an explanation would have to be augmented with an account of how familiarity is attributed to an item consequent to its linkage with an active concept, given that such an attribution would not be expected under standard priming mechanisms. In general, then, the present results suggest either 1) that the conceptual priming hypothesis needs to be modified to accommodate the occurrence of the conceptual processing advantage for stimuli without pre-existing conceptual representations or 2) that the hypothesis does not apply to such stimuli.

If the conceptual priming hypothesis cannot explain the occurrence of the conceptual processing advantage for stimuli without pre-existing conceptual representations, how might this phenomenon be explained? One possibility is that the phenomenon reflects an explicit memory process. Mulligan and Hirshman (1997) have proposed that the estimate of familiarity-based recognition produced by the process dissociation methodology reflects two components: positive familiarity assessment and non-diagnostic recollection. An item benefits from non–diagnostic recollection when the contextual information retrieved with the item is sufficient to establish the general situation in which the item was previously encountered, but insufficient to support

performance on the exclusion test. In the present study, the probability of familiarity-based recognition may have reflected non-diagnostic recollection as well as positive familiarity assessment. Non-diagnostic recollection may have been facilitated by conceptual processing at encoding. One problem for this account is that the conceptual processing advantage has been observed with the remember/know methodology as well as with the process dissociation methodology (Wagner, et al. 1997). It is possible, though, that explicit recognition memory corrupts estimates of implicit recognition memory obtained with the remember/know methodology as well as the process dissociation methodology. Alternatively, the conceptual processing advantage may reflect different mechanisms when observed with the process dissociation and the remember/know methodologies. Specifically, the advantage may reflect non-diagnostic recollection in the former case and conceptual priming in the latter case. A version of the present study using the remember/know methodology would shed useful light on this question.

We must also acknowledge that the conceptual processing advantage may be explicable without reference to the dual processing view. Under the assumption that recognition retrieval occurs at the conceptual level of representation, the phenomenon may be explicable simply in terms of transfer-appropriate processing (Lockhart, 2002). Conceptual processing at encoding may enhance all aspects of recognition memory simply because it is more consistent with the level of representation prevailing at retrieval. Notice that the conceptual priming hypothesis that we have challenged in the present paper is moot under this account.

The secondary results of the study are also of some interest. In both of the experiments, the probability of recollection showed a tendency toward being greater with conceptual than with perceptual processing. These results extend the results of previous work in which the effects of conceptual and perceptual processing have been assessed using stimuli with pre-existing conceptual representations and the remember/know procedure (Gardiner, 1988; Rajaram, 1993). Conceptual processing had a larger effect on familiarity-based recognition than on recollection in both experiments. This pattern contrasts with the one seen in some past work (Wagner et al., 1997). It is possible that the pattern observed here is characteristic of novel stimuli. The pattern may reflect the fact that non-diagnostic recollection plays a relatively large role in the recognition of novel stimuli. As might have been expected on intuitive grounds, the probability of familiarity-based recognition and recollection were greater, in both of the experiments, for items presented five times than for items presented once.

In conclusion, the present results suggest that familiarity-based recognition of stimuli without pre-existing conceptual representations is more greatly enhanced by conceptual then perceptual processing at encoding. These results suggest either that the conceptual priming hypothesis needs to be modified to accommodate the occurrence of the conceptual processing advantage for stimuli without pre-existing conceptual representations or that the hypothesis cannot explain the occurrence of the conceptual processing advantage for such stimuli.

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Appendix A

The following equations were used for calculating R, the probability of recollection and F, the probability of familiarity-based recognition for a given condition under the dual process signal detection model, assuming logistic distributions for the familiarity process.

$$R = -(POE' - POI' - 1)/2 - \{(POE' - POI' - 1)^2 - 4[POI'(1 - POE') - POE'(1 - POI')PNI'(1 - PNE')/PNE'(1 - PNI')]\}^{1/2} / 2$$

where POI' is the probability of making a positive response to a List1 1 item that fell into the condition in question and into the Inclusion condition, corrected as indicated in the text for limit situations, POE' is the probability of making a positive response to a List1 1 item that fell into the condition in question and into the Exclusion condition, similarly corrected, and PNI' and PNE' are the probabilities of making positive responses to new items in the Inclusion and Exclusion conditions, similarly corrected.

$$F = (xe^{\alpha})/(1 + xe^{\alpha} - x)$$

where x is the overall false alarm rate for the condition in question, *e* is the base of the natural logarithm, and

$$\alpha = \ln[(POI' - R)(1 - PNI') / PNI'(1 - POI')] = \ln[POE'(1 - PNE') / PNE'(1 - R - POE')]$$

where POI', POE', PNI', and PNE' are as defined above.

Figure captions

Figure 1. Design of Experiment 1.

Figure 2. Sample stimulus from Experiment 1.

Table 1

Experiment 1: Mean probability of a positive response to a List 1 design

Processing type	Test type	
	Inclusion	Exclusion
	One	
Conceptual	.654 (.241)	.284 (.220)
Perceptual	.368 (.156)	.246 (.270)
	Five	
Conceptual	.881 (.196)	.458 (.323)
Perceptual	.718 (.274)	.296 (.220)

Note. Standard deviations are given in parentheses.

Table 2

Experiment 1: Mean probability of a positive response to a new design

Processing type	Test Type	
	Inclusion	Exclusion
Conceptual	.178 (.132)	.134 (.109)
Perceptual	.236 (.233)	.215 (.307)

Note. Standard deviations are given in parentheses.

Table 3

Experiment 1: Mean probabilities of familiarity-based recognition and recollection, as given by the PD equations

Processing type	Frequency	
	Once	Five times
	Familiarity-based recognition	
Conceptual	.431 (.289)	.767 (.299)
Perceptual	.234 (.225)	.529 (.307)
	Recollection	
Conceptual	.370 (.331)	.424 (.387)
Perceptual	.121 (.239)	.421 (.371)

Note. Standard deviations are given in parentheses.

Table 4

Experiment 1: Mean probabilities of familiarity-based recognition and recollection, as given by the DPSD model

Processing type	Frequency	
	Once	Five times
	Familiarity-based recognition	
Conceptual	.470 (.249)	.777 (.212)
Perceptual	.292 (.218)	.548 (.271)
	Recollection	
Conceptual	.311 (.301)	.390 (.334)
Perceptual	.126 (.146)	.370 (.308)

Note. Standard deviations are given in parentheses.

Table 5

Experiment 2: Mean probability of a positive response to a List 1 string

Processing type	Test type	
	Inclusion	Exclusion
	Once	
Conceptual	.590 (.197)	.345 (.283)
Perceptual	.460 (.245)	.260 (.223)
	Five times	
Conceptual	.845 (.224)	.421 (.282)
Perceptual	.665 (.241)	.455 (.317)

Note. Standard deviations are given in parentheses.

Table 6

Experiment 2: Mean probability of a positive response to a new string

Processing type	Test type	
	Inclusion	Exclusion
Conceptual	.291 (.189)	.244 (.186)
Perceptual	.295 (.175)	.214 (.208)

Note. Standard deviations are given in parentheses.

Table 7

Experiment 2: Mean probabilities of familiarity-based recognition and recollection, as given by the PD equations

Processing type	Frequency	
	Once	Five times
	Familiarity-based recognition	
Conceptual	.444 (.217)	.665 (.200)
Perceptual	.352 (.174)	.547 (.207)
	Recollection	
Conceptual	.179 (.251)	.338 (.343)
Perceptual	.162 (.266)	.183 (.313)

Note. Standard deviations are given in parentheses.

Table 8

Experiment 2: Mean probabilities of familiarity-based recognition and recollection, as given by the DPSD model

Processing type	Frequency	
	Once	Five times
	Familiarity-based recognition	
Conceptual	.467 (.208)	.689 (.171)
Perceptual	.385 (.168)	.563 (.193)
	Recollection	
Conceptual	.196 (.198)	.317 (.271)
Perceptual	.121 (.175)	.166 (.192)

Note. Standard deviations are given in parentheses.

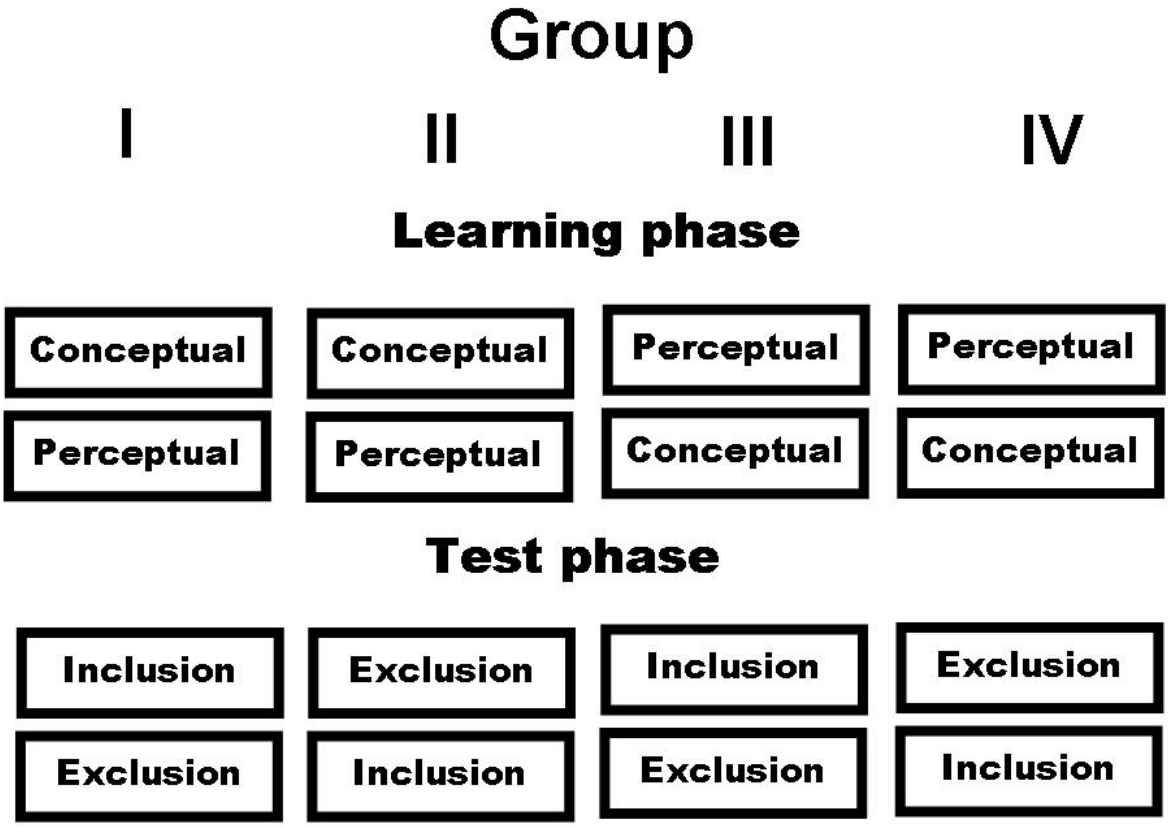
Group
I
II
III
IV
Learning phase
Conceptual
Perceptual
Conceptual
Perceptual
Perceptual
Conceptual
Perceptual
Conceptual
Test phase
Inclusion
Exclusion
Exclusion
Inclusion
Inclusion
Exclusion
Exclusion
Inclusion

Figure 1.

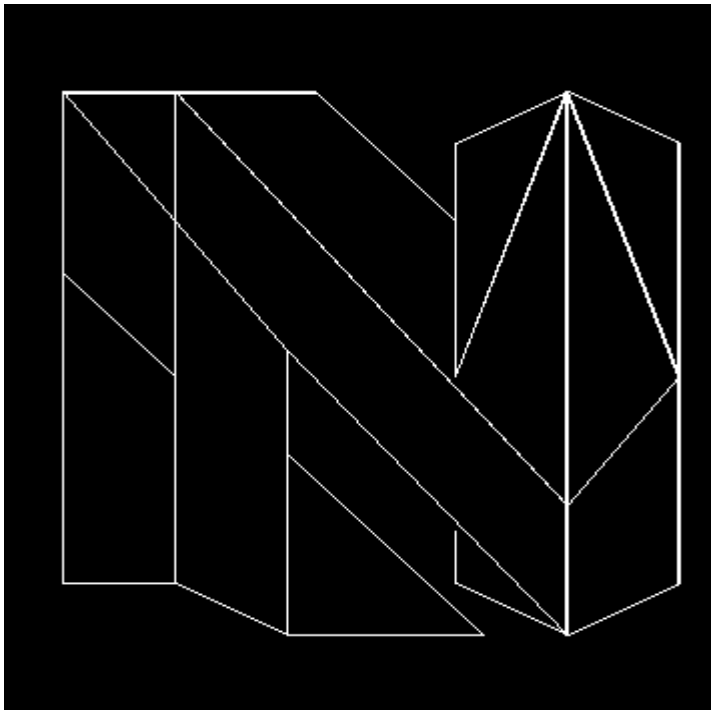

Figure 2