

## The Persistence of the Partial Cue-Induced Forgetting Effect: The Role of Item Value

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### Abstract

High-value items are typically better remembered than low-value items. At present, it remains unclear how item value influences the part-list cueing effect. By integrating the part-list cueing paradigm with value-directed memory tasks (Experiment 1), and further manipulating encoding conditions (1-study, 2-study-test) and test timing (immediate test, final test) (Experiment 2), this study investigated the effects of using items of different values as part-list cues on the recognition of test items of different values and the persistence of these effects. The results demonstrated that the values of both cue items and test items significantly affected the part-list cueing effect. Specifically: under the 1-study condition, high-value cues impaired recognition of both high- and low-value test items from immediate test through to final test, whereas low-value cues only impaired recognition of high-value test items at immediate test. Under the 2-study-test condition, only high-value cues impaired recognition of low-value test items from immediate test through to final test. These findings indicate that item value influences the magnitude and persistence of part-list cueing induced forgetting effects, and that when characterizing the role of part-list cues in memory retrieval from the perspective of inter-item associative encoding, the contribution of item value must be taken into consideration.

### Full Text

#### Persistence of Part-list Cuing-Induced Forgetting: The Role of Item Value

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## Abstract

High-value items are typically better remembered than low-value items. However, it remains unclear how item value influences the part-list cuing effect. This study investigated how part-list cues of different values affect recognition of target items with varying values and examined the persistence of these effects by combining the part-list cuing paradigm with a value-directed memory task (Experiment 1) and further manipulating encoding conditions (1-study vs. 2-study-test) and test schedules (immediate vs. final test) (Experiment 2). Results revealed that both cue and test item values significantly influenced the part-list cuing effect. Specifically, under the 1-study condition, high-value cues impaired recognition of both high- and low-value test items from immediate to final tests, whereas low-value cues only impaired high-value test items on the immediate test. Under the 2-study-test condition, only high-value cues caused persistent impairment to low-value test items from immediate to final tests. These findings demonstrate that item value affects both the magnitude and persistence of part-list cuing-induced forgetting, suggesting that the role of item value must be considered when defining how part-list cuing influences memory retrieval from the perspective of item associative encoding.

**Keywords:** part-list cuing, item value, encoding conditions, test schedule

In daily life, people encounter vast amounts of information with varying degrees of importance. Given the limited capacity of human attention and memory, the ability to selectively prioritize more valuable information represents a crucial control process that influences information processing efficiency. Research has shown that assigning high point values to certain items enhances their retention and retrieval in memory, a phenomenon known as value-directed remembering (VDR) (Castel et al., 2002; Castel et al., 2011; Castel et al., 2013; Cohen et al., 2016; Mason et al., 2017; Murphy et al., 2022; Stefanidi et al., 2018; Yin et al., 2021).

The most common paradigm for examining how item value affects memory is the value-directed memory paradigm (VDR paradigm). In this paradigm, each item is assigned a point value (or gold coins) during encoding (Castel et al., 2002; DeLozier & Rhodes, 2015; Elliott, Blais, et al., 2020; Middlebrooks et al., 2017; Robison & Unsworth, 2017; Stefanidi et al., 2018), and participants aim to earn as many points or rewards as possible by correctly remembering items. Significant value-directed memory effects have been observed in both free recall (Castel et al., 2002; Stefanidi et al., 2018) and recognition tests (Elliott, Blais, et al., 2020; Elliott et al., 2019; Gruber & Otten, 2010; Hennessee et al., 2017; Hennessee et al., 2019; Shigemune et al., 2014; Wittmann et al., 2005).

Value-directed memory research demonstrates that selectively focusing on important information (rather than non-critical information) can mitigate memory decline caused by information overload (Castel et al., 2002). However, it remains unclear whether item value also influences forgetting processes. Specifically, when learning items are assigned different values during encoding, does this amplify memory impairment or reduce forgetting? This study integrates value-directed memory with the part-list cuing effect—a forgetting phenomenon—to examine how item value influences susceptibility to retrieval interference. That is, we investigate how presenting items of different values as part-list cues during retrieval affects recall of other items with varying values.

The part-list cuing effect was first discovered by Slamecka (1968). It refers to the phenomenon where providing a subset of recently studied items as retrieval cues impairs recall of the remaining items compared to when no cues are provided (Nickerson, 1984; Slamecka, 1968). This forgetting effect has been observed across different test tasks (John & Aslan, 2018; Liu et al., 2020; Liu et al., 2022; Oswald et al., 2006), various experimental materials (Aslan et al., 2007; Fritz & Morris, 2015; Liu & Bai, 2017; Liu et al., 2021), and different age groups (John & Aslan, 2018; John & Aslan, 2020; Zellner & Bäuml, 2005; Tang et al., 2014).

Only a few studies have examined how cue characteristics influence the part-list cuing effect. Basden et al. (1977) manipulated the strength of part-list cue items and target items by varying their categorical dominance and found that while both high-dominance cues and targets improved recall of target items, the dominance ordering did not change the magnitude of the inhibitory effect. Kroeger et al. (2019) investigated how cue memorability affects the part-list cuing effect and found that high-memorability items as part-list cues produced significant interference, whereas low-memorability items did not. These studies suggest that target retrieval is influenced by characteristics of both cues and target items. In memory research, people selectively attend to important information, yet previous part-list cuing studies have typically treated all learning materials as equally important and selected cues randomly (often odd/even items from the original list to ensure uniform distribution), making all part-list cue items equivalent for participants. To date, no research has explored how manipulating item importance during encoding and using items of different values as part-list cues affects retrieval of other items with different values. Value-directed memory research shows that assigning high values to items enhances their representation strength in long-term memory (Hitch et al., 2018; Stefanidi et al., 2018), thereby modulating memory performance. This suggests that assigning different values to items may alter the magnitude or even direction of the part-list cuing effect by influencing processing depth and retrieval priority. Therefore, Experiment 1 of this study will first examine how using items of different values as part-list cues or test items influences the part-list cuing effect.

Based on this rationale, the present research combines the part-list cuing paradigm with the value-directed memory paradigm. Specifically, during the learning phase, participants study category exemplars assigned different

values (1 or 10 points). During the test phase, cue conditions are divided into high-value cues, low-value cues, and no-cue conditions. In the high- and low-value cue conditions, participants are presented with a subset of previously studied high- or low-value items as retrieval cues (in a different order from the learning phase) before completing a recognition test. In the no-cue condition, participants complete the recognition test directly. By comparing recognition performance across cue conditions, we can examine how cue value influences the part-list cuing effect, and by comparing recognition of high- versus low-value test items, we can examine how test item value influences the effect.

Current explanations for part-list cuing interference include the retrieval inhibition hypothesis and the strategy disruption hypothesis. The retrieval inhibition hypothesis posits that presenting part-list cues during testing causes individuals to first engage in implicit retrieval of the cue items, which leads to inhibition of non-cue items (target items), thereby producing the part-list cuing effect (Anderson et al., 1994; Aslan et al., 2007; Bäuml & Aslan, 2006). According to this hypothesis, high-value cue items have stronger representations than low-value cues, thus causing greater disruption to target items. Similarly, high-value target items have stronger representations than low-value targets, making them less susceptible to interference from part-list cues.

The strategy disruption hypothesis proposes that participants use specific strategies to encode experimental materials, and providing part-list cues disrupts these original retrieval strategies. This hypothesis suggests that part-list cues do not affect the representational level of items but influence recall solely by interfering with retrieval strategies (Basden et al., 2002; Basden & Basden, 1995; Basden et al., 1977). Given that part-list cues in this study are presented in a different order from learning, this hypothesis predicts that high- and low-value cues should have equivalent effects on retrieval performance.

Subsequently, Bäuml and Aslan (2006) proposed the two-mechanism hypothesis by manipulating encoding conditions (low-associative encoding with one study cycle vs. high-associative encoding with two study-test cycles) and test schedules (immediate test with part-list cues vs. final test without cues). They found that retrieval inhibition and strategy disruption operate under different circumstances. This hypothesis suggests that which impairment mechanism part-list cuing employs depends on encoding conditions: under low-associative encoding (when item associations and refined retrieval strategies are not established), cue items primarily interfere with target retrieval through retrieval inhibition; under high-associative encoding (when participants can establish extensive inter-item associations and refined serial retrieval strategies), interference occurs mainly through strategy disruption. Moreover, under low-associative encoding, the detrimental effects of part-list cuing reflect relatively persistent changes in target item activation levels, resulting in lasting impairment. Under high-associative encoding, part-list cuing causes temporary changes in retrieval strategies that can be restored when cues are removed, making forgetting transient and reversible. Many subsequent studies have supported the two-mechanism hypoth-

esis (Aslan & Bäuml, 2007; John & Aslan, 2020; Kelley et al., 2016; Muntean & Kimball, 2012).

The two-mechanism hypothesis manipulates high- and low-associative encoding through study-test cycles (Lehmer & Bäuml, 2018a, 2018b), whereas value-directed memory research shows that item value directly influences encoding strategies and subsequently affects the establishment of inter-item associations (Knowlton & Castel, 2022). This suggests that for items with different values, the degree of associative encoding achieved through the same number of learning trials differs. High-value items are more likely to establish inter-item associations compared to low-value items. Additionally, because high-value items receive more attentional processing during encoding (Allen, 2019), they have stronger representations that are less susceptible to decay or interference over time, leading to better long-term memory performance for high-value than low-value items. Therefore, item value may influence both the level of associative encoding and the persistence of the part-list cuing effect. That is, when item values differ, the part-list cuing effect may vary even under identical encoding requirements. Similarly, when encoding requirements differ, the same item value may produce different processing outcomes that subsequently affect the magnitude and persistence of the part-list cuing effect. This aspect has not been addressed by the two-mechanism hypothesis or previous research. Therefore, Experiment 2 further explores how items of different values, when serving as cues or targets (test items), affect recognition performance and its persistence under different encoding conditions, providing a test of the two-mechanism hypothesis. Following previous research, Experiment 2 defines low-associative encoding as studying the material once (John & Aslan, 2020) and high-associative encoding as completing two study-test cycles (Basden & Basden, 1995). To examine the persistence of item value effects on part-list cuing, two test phases are administered: an immediate test following part-list cue presentation and a final test administered after a 5-minute delay.

When item values differ, results may diverge from predictions of the two-mechanism hypothesis. Under low-associative encoding (1-study), high levels of inter-item interference may occur, but low-value items should cause less interference to high-value items than vice versa. Consequently, high-value test items should show less impairment than low-value items. Similarly, when high-value items serve as part-list cues, they should produce larger inhibitory effects than low-value cues, with these effects persisting across both immediate and final tests. Under high-associative encoding (2-study-test), inter-item interference decreases and participants may develop a preferred output order (when materials are learned through multiple study-test cycles, participants' recall order becomes more consistent across cycles; Bäuml & Aslan, 2006; Lehmer & Bäuml, 2018a). When asked to recall, participants prioritize this order over alternatives. Presenting part-list cues readily disrupts this preferred output order, producing interference. However, research shows that as inter-item associations increase, differences between cued and uncued recall performance decrease or disappear (Raaijmakers & Shiffrin, 1981), suggesting high-value

test items may be less affected or unaffected by part-list cuing. Additionally, because low-value items receive relatively shallow encoding, their impact on target retrieval strategies may be minimal, causing the disruptive effect to disappear when part-list cues are removed. Thus, under this scenario, the part-list cuing effect would be temporary and caused by strategy disruption.

In summary, this research investigates these questions through two experiments. Experiment 1 examines how items of different values, when serving as cues or targets (test items), influence the magnitude of the part-list cuing effect. Experiment 2 builds on Experiment 1 by further exploring how items of different values affect recognition performance and its persistence under different encoding conditions and test schedules.

## Experiment 1

### 2.1 Research Purpose

This experiment investigated how items of different values, when serving as cues, affect recognition performance of target items with varying values. Based on the retrieval inhibition hypothesis, we hypothesized that high-value cues would cause greater disruption to target item recognition than low-value cues, and that high-value target items would show higher recognition accuracy and shorter response times than low-value target items.

### 2.2 Participants

Referencing effect sizes from previous research (Kroeger et al., 2019) and using G\*Power 3.1 software (Faul et al., 2007) with Cohen's (1992) criteria ( $f = 0.25$ ,  $\alpha = 0.05$ ,  $1-\beta = 0.80$ ), the required total sample size was calculated as 19. Thirty university students (10 male) with a mean age of  $20.22 \pm 0.90$  years were recruited. All participants were right-handed with normal or corrected-to-normal vision. Participants provided informed consent before the experiment and received appropriate compensation afterward.

### 2.3 Materials

Experimental materials were selected from category word lists used by Yoon et al. (2004). All words were nouns (e.g., fruits, flowers) from 30 categories, with 12 exemplars per category. Eight exemplars from each category served as study items, while the remaining four served as new items during recognition. Materials were divided equally into three word lists, each containing 10 categories. Each list comprised 80 study items (40 high-value and 40 low-value; high-value items were assigned 10 points, low-value items 1 point) and 80 test items (20 high-value old words, 20 low-value old words, and 40 new words). Word frequency was determined using the *Modern Chinese Commonly Used Word Frequency Dictionary (Phonetic Order)* (Liu et al., 1990). Thirty university students who did not participate in the formal experiment rated the selected

two-character words on familiarity (1 = very unfamiliar to 7 = very familiar), emotional valence (1 = very unpleasant to 7 = very pleasant), and arousal (1 = very calm to 7 = very excited) using 7-point scales.

Statistical comparisons revealed no significant differences across the three word lists in word frequency ( $M_1 \pm SD_1 = 15.68 \pm 29.74$ ,  $M_2 \pm SD_2 = 15.32 \pm 17.30$ ,  $M_3 \pm SD_3 = 15.76 \pm 21.05$ ), study item frequency ( $M_1 \pm SD_1 = 15.79 \pm 29.70$ ,  $M_2 \pm SD_2 = 15.32 \pm 17.31$ ,  $M_3 \pm SD_3 = 15.58 \pm 21.12$ ), or test item frequency ( $M_1 \pm SD_1 = 15.92 \pm 38.09$ ,  $M_2 \pm SD_2 = 15.17 \pm 17.33$ ,  $M_3 \pm SD_3 = 15.96 \pm 25.30$ ), all  $F_s < 1$ ,  $p_s > 0.05$ . Similarly, no significant differences emerged for familiarity ( $M_1 \pm SD_1 = 5.99 \pm 0.69$ ,  $M_2 \pm SD_2 = 6.01 \pm 0.68$ ,  $M_3 \pm SD_3 = 5.97 \pm 0.50$ ), study item familiarity ( $M_1 \pm SD_1 = 6.06 \pm 0.69$ ,  $M_2 \pm SD_2 = 6.06 \pm 0.59$ ,  $M_3 \pm SD_3 = 6.06 \pm 0.37$ ), or test item familiarity ( $M_1 \pm SD_1 = 6.06 \pm 0.58$ ,  $M_2 \pm SD_2 = 6.06 \pm 0.67$ ,  $M_3 \pm SD_3 = 6.05 \pm 0.41$ ), all  $F_s < 1$ ,  $p_s > 0.05$ . Emotional valence also did not differ significantly across lists ( $M_1 \pm SD_1 = 4.06 \pm 0.67$ ,  $M_2 \pm SD_2 = 4.13 \pm 0.56$ ,  $M_3 \pm SD_3 = 4.11 \pm 0.58$ ), study items ( $M_1 \pm SD_1 = 4.07 \pm 0.73$ ,  $M_2 \pm SD_2 = 4.20 \pm 0.55$ ,  $M_3 \pm SD_3 = 4.11 \pm 0.63$ ), or test items ( $M_1 \pm SD_1 = 4.11 \pm 0.76$ ,  $M_2 \pm SD_2 = 4.17 \pm 0.58$ ,  $M_3 \pm SD_3 = 4.11 \pm 0.71$ ), all  $F_s < 1$ ,  $p_s > 0.05$ . Finally, arousal levels were comparable across lists ( $M_1 \pm SD_1 = 3.94 \pm 0.52$ ,  $M_2 \pm SD_2 = 3.98 \pm 0.49$ ,  $M_3 \pm SD_3 = 4.00 \pm 0.56$ ), study items ( $M_1 \pm SD_1 = 3.96 \pm 0.52$ ,  $M_2 \pm SD_2 = 4.03 \pm 0.49$ ,  $M_3 \pm SD_3 = 4.02 \pm 0.60$ ), and test items ( $M_1 \pm SD_1 = 4.02 \pm 0.54$ ,  $M_2 \pm SD_2 = 3.97 \pm 0.51$ ,  $M_3 \pm SD_3 = 4.05 \pm 0.66$ ), all  $F_s < 1$ ,  $p_s > 0.05$ .

## 2.4 Experimental Design

A 3 (cue condition: high-value cue/low-value cue/no cue)  $\times$  2 (test item value: high/low) within-subjects design was employed. Dependent variables were recognition accuracy and response time for test items.

## 2.5 Procedure

The experiment was programmed using E-Prime 2.0 software and presented on a Lenovo ThinkBook 14 laptop (14-inch screen, 1920 $\times$ 1080 resolution, 60 Hz refresh rate). To familiarize participants with the procedure, they completed practice trials for both cued and uncued conditions before the formal experiment. Each practice block consisted of 8 study trials and 8 test trials using materials not included in the formal experiment.

The formal experiment comprised three blocks, each corresponding to one cue condition, with block order randomized across participants. Each block included study, interference, and recognition test phases. The experimental procedure is illustrated in Figure 1 [Figure 1: see original paper].

**Study Phase:** Eighty exemplar words were presented sequentially on the computer screen in the format “category-exemplar points” (e.g., “shipping-steamer 10 points”). Each word was presented for 3000 ms, followed by a fixation cross

(+) in the center of the screen that served as both a fixation point and inter-stimulus interval (ISI = 1000 ms). The 80 words came from 10 categories, with 8 exemplars per category. Forty words were assigned 10 points and 40 were assigned 1 point. Participants were informed that their test score would be displayed after each test round and that higher scores would yield greater monetary compensation, which could be achieved by remembering more words or more high-value words. To match the relative presentation order of cue and target words and high- and low-value words, and to prevent associations among exemplars within the same category from providing additional retrieval cues, the 80 words were divided into 8 blocks during study. Each block contained one exemplar from each of the 10 categories. Within each block, high- and low-value words were equally represented, and their relative presentation order was matched. Two to three words per block were designated as cue words, with their relative presentation order controlled to ensure uniform distribution throughout the study list.

**Interference + Part-list Cue Phase / Interference Phase:** Participants performed continuous subtraction by 3 from a three-digit number. To ensure consistent study-test intervals across cued and uncued conditions, participants in the high-value and low-value cue conditions performed this task for 60 s. Following the math task, 20 of the 80 studied items were presented as retrieval cues for the upcoming test (20 high-value words in the high-value cue condition, 20 low-value words in the low-value cue condition; 2 per category). These items were presented pseudorandomly on a single screen for 40 s, and participants were instructed to read them carefully and use them as cues for recalling target items. In the no-cue condition, participants performed the math task for 100 s.

**Test Phase:** Eighty test items were presented sequentially on the screen, with a fixation cross (+) serving as both fixation point and ISI (1000 ms) between stimuli. Participants were instructed to make old/new judgments as quickly and accurately as possible, using the “F” and “J” keys on the keyboard. The next word appeared immediately after each response. Following the test, participants’ scores (the sum of points for correctly identified studied items) were displayed on the screen.

## 2.6 Results and Discussion

Recognition accuracy and response times were analyzed for each cue condition and test item value. Response times exceeding  $\pm 3$  standard deviations and incorrect responses were excluded from analysis. Results are shown in Figure 2 [Figure 2: see original paper].

A 3 (cue condition: high-value cue/low-value cue/no cue)  $\times$  2 (test item value: high/low) repeated-measures ANOVA on accuracy (with Greenhouse-Geisser correction for violations of sphericity and Bonferroni correction for multiple comparisons) revealed a significant main effect of cue condition,  $F(2, 58) = 8.99$ ,  $p < 0.001$ ,  $\eta^2_p = 0.24$ . Recognition accuracy was significantly higher in

the no-cue ( $p = 0.001$ ) and low-value cue ( $p = 0.013$ ) conditions than in the high-value cue condition, with no significant difference between no-cue and low-value cue conditions ( $p = 0.082$ ). The main effect of test item value was also significant,  $F(1, 29) = 18.99$ ,  $p < 0.001$ ,  $\eta^2_p = 0.40$ , with higher recognition accuracy for high-value than low-value test items. The interaction between cue condition and test item value was significant,  $F(2, 58) = 4.93$ ,  $p = 0.01$ ,  $\eta^2_p = 0.15$ . Simple effects analysis showed that for high-value test items,  $F(2, 28) = 4.16$ ,  $p = 0.026$ ,  $\eta^2_p = 0.23$ , recognition accuracy was significantly higher in the no-cue condition than in both low-value cue ( $p = 0.048$ ) and high-value cue ( $p = 0.045$ ) conditions, with no difference between the two cue conditions ( $p = 0.859$ ). For low-value test items,  $F(2, 28) = 7.48$ ,  $p = 0.002$ ,  $\eta^2_p = 0.35$ , recognition accuracy was significantly higher in both no-cue ( $p = 0.002$ ) and low-value cue ( $p = 0.004$ ) conditions than in the high-value cue condition, with no difference between no-cue and low-value cue conditions ( $p = 1.000$ ). In both high-value cue,  $F(1, 29) = 19.98$ ,  $p < 0.001$ ,  $\eta^2_p = 0.41$ , and no-cue conditions,  $F(1, 29) = 11.78$ ,  $p = 0.002$ ,  $\eta^2_p = 0.29$ , high-value test items showed significantly higher recognition accuracy than low-value test items, whereas in the low-value cue condition,  $F(1, 29) = 2.59$ ,  $p = 0.12$ , the difference between high- and low-value test items was not significant.

A 3 (cue condition: high-value cue/low-value cue/no cue)  $\times$  2 (item value: high/low) repeated-measures ANOVA on response times revealed a significant main effect of cue condition,  $F(2, 58) = 4.89$ ,  $p = 0.011$ ,  $\eta^2_p = 0.14$ . Response times were significantly longer in the high-value cue condition than in the no-cue condition ( $p = 0.004$ ), with no significant difference between low-value cue and no-cue conditions ( $p = 0.064$ ) or between high- and low-value cue conditions ( $p = 0.275$ ). The main effect of item value was significant,  $F(1, 29) = 8.06$ ,  $p = 0.008$ ,  $\eta^2_p = 0.22$ , with shorter response times for high-value than low-value words. The interaction was not significant,  $F(2, 58) = 2.10$ ,  $p > 0.05$ .

Experiment 1 examined how items of different values, when serving as cues or targets, influence the part-list cuing effect. Results showed that providing part-list cues significantly reduced recognition accuracy compared to the no-cue condition, with poorer recall performance in the high-value cue condition than in the low-value cue condition. Response times were significantly shorter in the no-cue condition than in cued conditions. These findings align with previous part-list cuing research (Aslan & Bäuml, 2009; Bäuml & Aslan, 2006; Bäuml & Samenieh, 2012). Regarding item value, recognition accuracy was significantly higher for high-value test items than low-value test items, consistent with value-directed memory research (Middlebrooks & Castel, 2018; Villasenor et al., 2021). Moreover, in both no-cue and high-value cue conditions, recognition performance was better for high-value than low-value test items, whereas in the low-value cue condition, the difference between high- and low-value test items was not significant. This indicates that using items of different values as cues produces differential impairment for test items of different values. Unlike previous research, this study manipulated item values during encoding and found that presenting items of different values as cues during the cueing phase

produced different degrees of interference with target items, with high-value cues causing stronger interference than low-value cues by enhancing cue representation.

Based on these findings, Experiment 2 added encoding condition and test schedule manipulations to further examine how items of different values, when serving as cues or targets (test items), affect recognition performance and its persistence under different encoding conditions and test schedules.

## Experiment 2

### 3.1 Research Purpose

Building on Experiment 1, this experiment further explored how items of different values, when serving as cues or targets (test items), affect recognition performance under different encoding conditions and test schedules. We hypothesized that the 1-study condition would produce high levels of inter-item interference, triggering inhibitory mechanisms when part-list cues were presented, resulting in relatively persistent impairment caused by retrieval inhibition. In contrast, the 2-study-test condition would foster a preferred output order that would be readily disrupted by part-list cues, with the disruptive effect disappearing when cues were removed, resulting in transient impairment caused by strategy disruption.

### 3.2 Participants

Referencing effect sizes from previous research (John & Aslan, 2020) and using G\*Power 3.1 software (Faul et al., 2007) with Cohen's (1992) criteria ( $f = 0.30$ ,  $\alpha = 0.05$ ,  $1 - \beta = 0.80$ ), the required total sample size was calculated as 50. Seventy-four university students (mean age =  $20.83 \pm 1.74$  years) were recruited and divided into two groups: 38 participants in the "1-study" condition (13 male; 1 excluded due to key-press errors) and 36 in the "2-study-test" condition (12 male). All participants were right-handed with normal or corrected-to-normal vision, provided informed consent, and received appropriate compensation.

### 3.3 Materials

The materials were identical to those used in Experiment 1.

### 3.4 Experimental Design

A 2 (encoding condition: 1-study/2-study-test)  $\times$  3 (cue condition: high-value cue/low-value cue/no cue)  $\times$  2 (test item value: high/low)  $\times$  2 (test schedule: immediate test/final test) mixed design was employed. Encoding condition was a between-subjects factor, while the remaining three factors were within-subjects. Dependent variables were recognition accuracy and response time for test items.

### 3.5 Procedure

The experiment was programmed and practice requirements were identical to Experiment 1. In the formal experiment, each participant completed three blocks, each corresponding to one cue condition, with block order randomized. Each block included study, interference 1, immediate test, interference 2, and final test phases. The experimental procedure is illustrated in Figure 3 [Figure 3: see original paper].

**Study Phase:** Eighty exemplar words were presented sequentially in the format “category-exemplar points” (e.g., “shipping-steamer 10 points”) for 3000 ms each, with a fixation cross (+) as both fixation point and ISI (1000 ms). The 80 words came from 10 categories with 8 exemplars per category (40 high-value, 40 low-value). Participants were informed that higher test scores would yield greater monetary compensation, achievable by remembering more words or more high-value words. To match the relative presentation order of cue and target words and high- and low-value words, and to prevent within-category associations from providing additional retrieval cues, the 80 words were divided into 8 blocks, each containing one exemplar from each category. Each block contained equal numbers of high- and low-value words with matched presentation order, and 2-3 cue words with controlled presentation order. In the 1-study condition, participants completed only one study cycle. In the 2-study-test condition, participants completed two study-test cycles (study-test-study-test), with test and retest phases using a word-stem completion task (e.g., presenting “shipping-ste\_\_\_\_\_” for participants to complete on paper). Test and retest items were presented in the same order as during study, with self-paced timing (participants pressed the spacebar after completing each item to proceed).

**Interference 1 + Part-list Cue Phase / Interference 1 Phase:** Participants performed continuous subtraction by 3 from a three-digit number. To ensure consistent study-test intervals, participants in cued conditions performed this task for 60 s, after which 20 of the 80 studied items were presented as retrieval cues (20 high-value words in the high-value cue condition, 20 low-value words in the low-value cue condition; 2 per category). These items were presented pseudorandomly on a single screen for 40 s, with instructions to read them carefully and use them as cues for recalling target items. In the no-cue condition, participants performed the math task for 100 s.

**Immediate Test Phase:** Eighty test items were presented sequentially with a fixation cross (+) as both fixation point and ISI (1000 ms). Participants made old/new judgments using the “F” and “J” keys as quickly and accurately as possible. After each response, the next word appeared. Following the test, participants’ scores were displayed.

**Interference Phase 2:** Participants completed a 5-minute distractor task involving continuous subtraction by 7 from a three-digit number.

**Final Test Phase:** Eighty test items were presented sequentially with a fixation

cross (+) as both fixation point and ISI (1000 ms). Participants made old/new judgments using the “F” and “J” keys. After each response, the next word appeared. Following the test, participants’ scores were displayed.

### 3.6 Results and Discussion

Recognition accuracy and response times were analyzed for each cue condition and test item value. Response times exceeding  $\pm 3$  standard deviations and incorrect responses were excluded. Results are shown in Figure 4 [Figure 4: see original paper].

Following previous research (Aslan & Bäuml, 2007; John & Aslan, 2020), separate 3 (cue condition: high-value cue/low-value cue/no cue)  $\times$  2 (test item value: high/low)  $\times$  2 (test schedule: immediate test/final test) repeated-measures ANOVAs were conducted on accuracy for the 1-study and 2-study-test conditions.

**1-Study Condition:** The main effect of cue condition was significant,  $F(2, 72) = 23.29$ ,  $p < 0.001$ ,  $\eta^2_p = 0.39$ , with higher recognition accuracy in the no-cue than in both high-value and low-value cue conditions, and higher accuracy in the low-value than high-value cue condition. The main effect of test item value was significant,  $F(1, 36) = 12.68$ ,  $p < 0.001$ ,  $\eta^2_p = 0.26$ , with higher accuracy for high-value than low-value test items. The main effect of test schedule was significant,  $F(1, 36) = 16.16$ ,  $p < 0.001$ ,  $\eta^2_p = 0.31$ , with higher accuracy on the final than immediate test. The three-way interaction among cue condition, test item value, and test schedule was significant,  $F(2, 72) = 3.89$ ,  $p = 0.025$ ,  $\eta^2_p = 0.10$ . Simple effects tests showed that on the immediate test, high-value test items had higher recognition accuracy than low-value test items in both the high-value cue condition,  $F(1, 36) = 6.52$ ,  $p = 0.015$ ,  $\eta^2_p = 0.15$ , and no-cue condition,  $F(1, 36) = 11.93$ ,  $p = 0.001$ ,  $\eta^2_p = 0.25$ , but not in the low-value cue condition,  $F(1, 36) = 1.92$ ,  $p = 0.174$ . On the final test, high-value test items showed significantly higher accuracy than low-value test items only in the high-value cue condition,  $F(1, 36) = 13.93$ ,  $p = 0.001$ ,  $\eta^2_p = 0.28$ , with marginal differences in the low-value cue,  $F(1, 36) = 3.74$ ,  $p = 0.061$ , and no-cue conditions,  $F(1, 36) = 3.70$ ,  $p = 0.062$ .

In the high-value cue condition, both high-value,  $F(1, 36) = 5.47$ ,  $p = 0.025$ ,  $\eta^2_p = 0.13$ , and low-value test items,  $F(1, 36) = 4.75$ ,  $p = 0.036$ ,  $\eta^2_p = 0.12$ , showed significantly lower accuracy on the immediate than final test. In the low-value cue condition, both high-value,  $F(1, 36) = 12.41$ ,  $p = 0.001$ ,  $\eta^2_p = 0.26$ , and low-value test items,  $F(1, 36) = 12.25$ ,  $p = 0.001$ ,  $\eta^2_p = 0.25$ , also showed lower immediate than final test accuracy. In the no-cue condition, high-value test items showed no significant difference between immediate and final tests,  $F(1, 36) = 0.70$ ,  $p = 0.409$ , whereas low-value test items showed lower immediate than final test accuracy,  $F(1, 36) = 9.98$ ,  $p = 0.003$ ,  $\eta^2_p = 0.22$ .

For high-value test items, on the immediate test, recognition accuracy was significantly higher in the no-cue than in both high-value cue,  $p < 0.001$ , and

low-value cue,  $p = 0.008$ , conditions, with no difference between cue conditions,  $p = 0.172$ . On the final test, accuracy was significantly higher in both no-cue,  $p = 0.001$ , and low-value cue,  $p = 0.014$ , conditions than in the high-value cue condition, with no difference between no-cue and low-value cue conditions,  $p = 0.577$ . For low-value test items, on the immediate test, accuracy was significantly higher in both no-cue,  $p = 0.004$ , and low-value cue,  $p = 0.017$ , conditions than in the high-value cue condition, with no difference between no-cue and low-value cue conditions,  $p = 1.000$ . On the final test, accuracy was significantly higher in both no-cue,  $p < 0.001$ , and low-value cue,  $p = 0.010$ , conditions than in the high-value cue condition, with no difference between no-cue and low-value cue conditions,  $p = 0.422$ .

**2-Study-Test Condition:** The main effect of cue condition was significant,  $F(2, 70) = 6.07$ ,  $p = 0.004$ ,  $\eta^2_p = 0.15$ , with higher accuracy in the no-cue than high-value cue condition,  $p = 0.004$ . No significant differences emerged between low-value and high-value cue conditions,  $p = 0.262$ , or between no-cue and low-value cue conditions,  $p = 0.168$ . The main effect of test item value was significant,  $F(1, 35) = 7.75$ ,  $p = 0.009$ ,  $\eta^2_p = 0.18$ , with higher accuracy for high-value than low-value test items. The interaction between cue condition and test item value was significant,  $F(2, 70) = 4.09$ ,  $p = 0.021$ ,  $\eta^2_p = 0.11$ . Simple effects tests showed that for high-value test items, no significant differences emerged among no-cue, high-value cue, and low-value cue conditions,  $F(2, 34) = 2.67$ ,  $p = 0.084$ . For low-value test items, recognition accuracy was significantly higher in both no-cue,  $p = 0.015$ , and low-value cue,  $p = 0.020$ , conditions than in the high-value cue condition, with no difference between no-cue and low-value cue conditions,  $p = 1.000$ . In both high-value cue,  $F(1, 35) = 8.40$ ,  $p = 0.006$ ,  $\eta^2_p = 0.19$ , and no-cue conditions,  $F(1, 35) = 4.10$ ,  $p = 0.050$ ,  $\eta^2_p = 0.11$ , high-value test items showed higher accuracy than low-value test items, whereas in the low-value cue condition,  $F(1, 35) = 0.04$ ,  $p = 0.852$ , the difference was not significant.

Separate  $3$  (cue condition: high-value cue/low-value cue/no cue)  $\times 2$  (test item value: high/low)  $\times 2$  (test schedule: immediate test/final test) repeated-measures ANOVAs were conducted on response times for the 1-study and 2-study-test conditions. In the 1-study condition, the main effect of cue condition was significant,  $F(2, 72) = 4.75$ ,  $p = 0.012$ ,  $\eta^2_p = 0.12$ , with longer response times in both high-value and low-value cue conditions than in the no-cue condition, and no difference between cue conditions. The main effect of test item value was significant,  $F(1, 36) = 13.17$ ,  $p = 0.001$ ,  $\eta^2_p = 0.27$ , with shorter response times for high-value than low-value test items. The main effect of test schedule was significant,  $F(1, 36) = 18.18$ ,  $p < 0.001$ ,  $\eta^2_p = 0.34$ , with longer response times on the immediate than final test. No other interactions were significant. In the 2-study-test condition, only the main effect of test schedule was significant,  $F(1, 35) = 4.39$ ,  $p = 0.043$ ,  $\eta^2_p = 0.11$ , with longer response times on the immediate than final test. No other main effects or interactions were significant,  $F_s < 2.50$ ,  $p_s > 0.05$ .

Experiment 2 replicated the finding that recognition accuracy was significantly higher and response times significantly shorter for high-value than low-value test items, consistent with previous value-directed memory research (Middlebrooks et al., 2016; Murphy et al., 2022). Recognition accuracy was significantly higher in the no-cue than cued conditions, generally consistent with Experiment 1. More importantly, Experiment 2 revealed that the persistence of part-list cuing varied across encoding conditions and item values. Under the 1-study condition, high-value cues impaired recognition of both high- and low-value target items from immediate to final tests, whereas low-value cues impaired recognition of high-value test items only on the immediate test and showed no significant impairment for low-value test items. Under the 2-study-test condition, neither high- nor low-value cues significantly impaired recognition of high-value target items on either test, while only high-value cues impaired recognition of low-value test items across both immediate and final tests.

## General Discussion

Previous part-list cuing research has typically assumed equivalence among all learning and test items, rarely considering how differential item values might influence the effect. By manipulating item importance during encoding, this study is the first to examine how part-list cues of different values affect recognition of test items with varying values, enriching our understanding of the mechanisms and influencing factors of the part-list cuing effect.

Experiment 1 investigated how items of different values, when serving as cues or targets (test items), influence the part-list cuing effect. Results showed that both high- and low-value cues significantly reduced target item recognition accuracy, consistent with previous part-list cuing research (Aslan et al., 2007; Aslan & Bäuml, 2007; Bäuml & Samenieh, 2012; Liu et al., 2020; Wallner & Bäuml, 2021; Bai et al., 2014; Liu et al., 2019), confirming that part-list cues impair recognition performance. When cue and test items were assigned different values, the part-list cuing effect varied: recognition accuracy was significantly lower with high-value than low-value cues, with high-value cues impairing both high- and low-value test items, while low-value cues impaired only high-value test items. This indicates that high-value cues produce stronger interference than low-value cues. High-value test items were impaired by both high- and low-value cues, whereas low-value test items were impaired only by high-value cues. Compared to the high-value cue condition, low-value cues did not significantly improve recognition of high-value test items but did significantly improve recognition of low-value test items, and the difference between high- and low-value test items was not significant in the low-value cue condition. Although high-value test items showed higher overall recognition accuracy, they were more sensitive to part-list cue presentation than low-value test items.

Value-directed memory research indicates that assigning different values to items changes their representational strength (Elliott, McClure, et al., 2020; Knowlton & Castel, 2022; Villasenor et al., 2021), with high-value items having stronger

representations and low-value items weaker ones. According to the retrieval inhibition hypothesis, presenting part-list cues during testing causes individuals to first engage in implicit retrieval of cue items. However, non-cue items (target items) compete with this implicit retrieval. When low-value cues are presented, high-strength non-cue items strongly interfere with implicit retrieval of low-value cues. Conversely, when high-value cues are presented, low-strength non-cue items produce weak or no interference with implicit retrieval of high-value cues (Storm & Bui, 2016). This represents a form of “reverse competition” from non-cue items against cue items. To overcome this interference and complete implicit retrieval of cue items, an inhibitory mechanism is activated to suppress the memory representations of non-cue items. This suppression reduces the representational strength of these items, causing subsequent memory impairment for non-cue items (Barber et al., 2015; Crescentini et al., 2010). Therefore, when high-value items serve as cues, their stronger representations produce greater inhibition of target items. In the low-value cue condition, low-value cues that experienced strong interference during cue presentation can hardly disrupt test items, while the strong interference experienced by high-strength non-cue items (test items) during cue presentation leads to impairment of their own representational strength. To overcome this interference and complete implicit retrieval of cue items, the inhibitory mechanism suppresses the representations of non-cue items, reducing the strength of high-strength test items and impairing their subsequent recall. Experiment 1 results only partially supported the retrieval inhibition hypothesis regarding cue value but not test item value. One possible reason is that high-value items have inherently stronger representations than low-value items (Basden et al., 1977; Kroeger et al., 2019). Therefore, when serving as cues, they strongly inhibit test items, but when serving as test items, they may automatically initiate reverse competition against cue items, making their representational strength more vulnerable to cue influence. Additionally, because the part-list cuing effect is examined by comparing performance for test items of the same value across cue conditions (i.e., whether high- and low-value cues impair test items is determined by comparing them to the corresponding high- and low-value test items in the no-cue condition), while value effects are examined by comparing different-value test items within the same cue condition, the impairment pattern differs. Although low-value test items were impaired only by high-value cues and low-value cues impaired only high-value test items on the immediate test, low-value test items still showed greater overall impairment than high-value items because their recognition accuracy in the no-cue condition was significantly lower than that of high-value test items.

Experiment 2 further examined how items of different values, when serving as cues or test items, affect recognition performance under different encoding conditions and test schedules. Under low-associative encoding, both high- and low-value cues impaired high-value test items on the immediate test, while only high-value cues impaired low-value test items. This pattern replicated Experiment 1, again demonstrating asymmetric effects of cue and test item values on part-list cuing. On the final test under low-associative encoding, both high-

and low-value test items continued to show impairment from high-value cues. Because the immediate test occurred immediately after cue presentation while the final test occurred after a 5-minute delay, the interference from high-value cues persisted across both tests, indicating relatively lasting impairment. This finding aligns with the two-mechanism hypothesis, which posits that under low-associative encoding, cue items primarily interfere with target retrieval through retrieval inhibition, producing relatively persistent impairment that reflects lasting changes in target item activation levels (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006; John & Aslan, 2020). John and Aslan (2020) found that 12- to 14-year-old children, like adults, showed persistent part-list cuing effects under 1-study conditions but transient impairment under 2-study-test conditions. In contrast, younger children (ages 7-8 and 9-10) showed persistent effects under both encoding conditions, revealing age differences in the persistence of part-list cuing that suggest additional factors influence its effects and persistence. In Experiment 2, low-value cues impaired high-value test items only on the immediate test, with the effect disappearing on the final test, indicating transient interference. Although high-value test items were more sensitive to cue presentation, their strong representations were more easily reactivated, allowing their representational strength to recover when cues were removed or when the interval between cueing and testing was longer. This result is inconsistent with the two-mechanism hypothesis. The lack of significant impairment from low-value cues to low-value test items also contradicts the hypothesis that low-associative encoding necessarily produces persistent interference (Lehmer & Bäuml, 2018a, 2018b). These findings demonstrate that even under identical low-associative encoding requirements, part-list cuing effects are not necessarily persistent, and item value influences both the magnitude and duration of the effect.

According to the two-mechanism hypothesis, high-level associative encoding leads to more advanced integrative processing, making encoding strategies more influential. Consequently, part-list cuing interference primarily reflects strategy disruption that disappears when cues are removed on subsequent tests (Aslan & Bäuml, 2007; Bäuml & Aslan, 2006; John & Aslan, 2020). Under high-associative encoding in Experiment 2, high-value test items were unaffected by part-list cues on either immediate or final tests, while only high-value cues impaired low-value test items across both tests. This pattern cannot be explained by the two-mechanism hypothesis. The strategy disruption hypothesis posits that part-list cuing effects are transient and disappear when cues are removed (Basden & Basden, 1995; Reysen & Nairne, 2002). The current findings challenge strategy disruption under high-associative encoding in two ways: First, to examine whether interference occurs immediately after cue presentation, participants in Experiments 1 and 2 performed recognition tasks immediately after cueing, yet part-list cuing effects were still observed. Second, Experiment 2 included a second retrieval task without cue presentation, yet recognition performance in cued conditions remained lower than in the no-cue condition.

Combined results from low- and high-associative encoding conditions suggest that encoding condition primarily influences the magnitude of part-list cuing ef-

fects. Under high-associative encoding, deep processing of materials reduces the overall interference effect (Basden & Basden, 1995; Lehmer & Bäuml, 2018a), making it weaker and more limited in scope. Under low-associative encoding, limited encoding depth (John & Aslan, 2020) produces stronger and more widespread interference. Item value, however, influences the persistence of part-list cuing effects. Under low-associative encoding, impairment from both high- and low-value cues to high-value test items persisted from immediate to final tests, as did the lack of impairment from low-value cues to low-value test items. In contrast, impairment from low-value cues to high-value test items was transient. Under high-associative encoding, impairment from high-value cues to low-value test items persisted across both tests, as did the lack of impairment to high-value test items. Thus, both cue item value and test item value jointly influence the persistence of part-list cuing effects. These findings suggest that the role of part-list cuing in memory retrieval may not necessarily manifest as lasting impairment under low-associative encoding or transient impairment under high-associative encoding, as proposed by the two-mechanism hypothesis. Instead, when cue items have high value and strong representations, they can produce lasting reductions in representational strength of test items through retrieval inhibition, particularly when test items have relatively weak representations. However, when test items receive high-level integrative processing (such as high-value items under high-associative encoding), part-list cuing cannot effectively suppress their representational strength. When cue items have low value and weak representations, they cannot produce lasting inhibition of test item representations even under low-associative encoding, nor can they strongly disrupt retrieval strategies under high-associative encoding.

In conclusion, two behavioral experiments yielded the following findings: (1) High-value cue items cause greater disruption to target item recognition than low-value cue items. High-value target items show higher recognition accuracy than low-value targets but are more sensitive to cue presentation. (2) Item value influences both the magnitude and persistence of part-list cuing effects. Under the 1-study condition, high-value cues impaired recognition of both high- and low-value test items from immediate to final tests, whereas low-value cues impaired only high-value test items on the immediate test. Under the 2-study-test condition, only high-value cues caused persistent impairment to low-value test items from immediate to final tests. These results partially validate the two-mechanism hypothesis while providing a necessary supplement: the role of part-list cuing in memory retrieval does not necessarily produce lasting impairment under low-associative encoding or transient impairment under high-associative encoding. Item value also influences the strength and duration of part-list cuing effects, and must be considered when defining how part-list cuing affects memory retrieval from the perspective of item associative encoding.

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