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Congruity Effects Between Materials and Processing Tasks in the Survival Processing Paradigm

Andrew C. Butler, Sean H. K. Kang, and Henry L. Roediger, III
Washington University in St. Louis

Nairne, Thompson, and Pandeirada (2007) reported a series of experiments in which processing unrelated words in terms of their relevance to a grasslands survival scenario led to better retention relative to other semantic processing tasks. The impetus for their study was the premise that human memory systems evolved under the selection pressures of our ancestral past. In 3 experiments, we extended this functional approach to investigate the congruity effect—the common finding that people remember items better if those items are congruent with the way in which they are processed. Experiment 1 was a replication of Nairne et al.'s (2007) experiment and showed congruity effects in the survival processing paradigm. To avoid potential item-selection artifacts from randomly selected words, we manipulated congruence between words and processing condition in Experiments 2 and 3. As expected, final recall was highest when the type of processing and the materials were congruent, indicating that people remember stimuli better if the stimuli are congruent with the goals associated with their processing. However, contrary to our predictions, no survival processing advantage emerged between the 2 congruent conditions or for a list of irrelevant words. When congruity was controlled in a mixed list design, the survival processing advantage disappeared.

Keywords: survival, congruity effects, evolution, memory, levels of processing

Nairne, Thompson, and Pandeirada (2007) reported a series of experiments in which rating words with respect to their relevance to survival in a grasslands scenario, termed *survival processing*, led to superior retention of the words relative to other semantic encoding tasks. The impetus for the study was the idea that the human brain evolved under the selection pressures of our ancestral past and therefore that our memory systems have been shaped to remember information that is processed with respect to its relevance for survival. To test this hypothesis, they compared instructions that required subjects to consider words in terms of their survival value to several other semantic encoding tasks using the classic levels-of-processing paradigm (Craik & Tulving, 1975; Hyde & Jenkins, 1969) in which items are rated with respect to their relevance on various dimensions (e.g., pleasantness, among many others). The results of their initial experiments strongly supported their hypothesis in that words encoded with regard to survival were recalled and recognized better than words encoded in terms of pleasantness or numerous other semantic dimensions (Nairne et al., 2007). In addition, several follow-up studies have replicated and extended these results (Kang, McDermott, & Cohen, 2008; Nairne & Pandeirada, 2007; Nairne, Pandeirada, & Thompson, 2008; Weinstein, Bugg, & Roediger, 2008).

Briefly, the experiments conducted by Nairne and his colleagues showed that survival processing produced a mnemonic advantage over a veritable "murderers' row" of semantic encoding tasks that have been previously found to promote superior retention, including encoding in terms of self-reference (Roger, Kuiper, & Kirker, 1977), pleasantness (Packman & Battig, 1978), imagery (Paivio, 1969), and generation (Slamecka & Graf, 1978). In addition, survival processing also produced better retention than several thematic scenarios that were generally matched in terms of complexity but did not contain the element of survival, such as "moving to a foreign land" (Nairne et al., 2007), "going on vacation" (Nairne et al., 2008), and "planning a zoo party" (Nairne & Pandeirada, 2007).

Other researchers have replicated the survival processing effect with different scenarios and new lists of words. Kang et al. (2008) reported three experiments in which the survival scenario produced better retention than a bank robbery scenario, which was intended to act as a control for the arousal and novelty of the survival scenario. Similarly, Weinstein, Bugg, and Roediger (2008; Experiment 1) replicated Nairne et al.'s (2007) effect with a new set of randomly selected words in an experiment in which the grasslands survival scenario was compared with the moving scenario. They also showed that rating words in terms of the grassland survival scenario produced better recall than a processing task in which students were asked to rate the words on their relevance to survival in an unfamiliar city. This outcome (as well as the advantage of the grasslands scenario over the bank robbery scenario) seems to implicate a role of ancestral survival in the survival processing effect. Taken as a whole, these studies support the conclusion that "survival processing is one of the best—if not *the* best—encoding procedures yet identified" (Nairne et al., 2008, p. 180).

The purpose of the present research was to investigate a finding from the Nairne et al. (2007) study that was briefly discussed but largely dismissed as unimportant: the superior retention of items that were rated as highly relevant to the scenario. In Experiment 1, Nairne

Andrew C. Butler, Sean H. K. Kang, & Henry L. Roediger, III, Department of Psychology, Washington University in St. Louis.

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Correspondence concerning this article should be addressed to Andrew C. Butler, Department of Psychology, Washington University in St. Louis, Campus Box 1125, St. Louis, MO 63130. E-mail: butler@wustl.edu

et al. reported that "participants were more likely to recall items given a high survival relevance rating—in fact, retention increased monotonically with the average rating . . . ." (p. 265). As Nairne et al. pointed out, this result can be interpreted as a congruity effect—the common finding that people remember items better if those items are congruent with the way in which they are processed. Results of traditional levels-of-processing experiments in which questions are used to orient subjects to different features of words (Craik & Tulving, 1975) consistently show that words are better remembered when the answer to the encoding question is "yes" than when the answer is "no" (e.g., Craik, 1973; Moscovitch & Craik, 1976; Schulman, 1974). For example, if the question posed during the encoding task is "Is it an animal?," then the answer would be "yes" for "bear" and "no" for "chair," and the word in the former condition would be better remembered on a subsequent test.

The fact that words evoking *yes* responses in semantic tasks lead to better recall than those producing *no* responses represented a problem for the original levels-of-processing framework (for discussion, see Lockhart & Craik, 1990; Roediger & Gallo, 2002). After all, the subject must think about the meaning of both *bear* and *chair* to answer the question correctly, so why should positive responses lead to better recall and recognition than negative responses? One explanation put forth was that congruence between the processing task and target words leads to richer or more elaborate encoding (Schulman, 1974). In the same vein, Craik and Tulving (1975) argued that ". . . in cases where a positive response is made, the encoding question and the target word can form a coherent, integrated unit . . ." (p. 281). These ideas provide a plausible account of congruity effects and remain widely accepted.

Within the levels-of-processing literature, congruity effects alternately represent a topic of investigation and a potential confounding factor that researchers seek to control. Because of the importance of congruity effects in the levels-of-processing paradigm, we designed a set of three experiments to explore how congruence between the type of processing and the to-be-remembered item affects subsequent memory performance in the survival processing paradigm (Nairne et al., 2007). In Experiment 1, we sought to show the basic survival processing effect by replicating Nairne et al.'s (2007) experiment with an additional goal of examining the congruity effect in more detail through conditional analyses. In Experiments 2 and 3, we manipulated the congruence between the type of processing and the to-be-encoded items in order to have better control over the materials than had been achieved in previous research. In almost all prior published experiments, random word lists have been used (for an exception, see Nairne & Pandeirada, 2008b).

Experiment 1

Experiment 1 was a replication of the first experiment reported in Nairne et al. (2007) in which we used exactly the same materials and procedure. Subjects rated a list of words with respect to their relevance to a scenario that involved either survival in the grasslands of a foreign land (survival processing) or moving to a new home in a foreign land (moving processing). In the rating task, all subjects saw a list of 32 words, each of which was presented for 5 s and rated each word on a scale of 1–5 for the relevant scenario. After performing a brief distractor task, they were given 10 min to recall as many of the words as they could.

Method

Subjects. Subjects were 40 undergraduate psychology students at Washington University in St. Louis who participated for course credit. All subjects were treated in accordance with the Ethical Principles of Psychologists and Code of Conduct put forth by the American Psychological Association (2002).

Materials. The stimuli consisted of 32 words used in Experiment 1 of Nairne et al. (2007). Individual PCs running E-Prime software (Schneider, Eschman, & Zuccolotto, 2002) were used to present all the words and collect rating and reaction time data.

Procedure. The experiment consisted of a single session that lasted approximately 25 min. Subjects were seated at a computer terminal and told that the experiment involved rating words according to their relevance to a particular scenario. The survival and the moving scenarios were the same as those used in Nairne et al. (2007). The instructions for the two scenarios were as follows:

> *Survival:* In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this survival situation. Some of the words may be relevant and others may not—it's up to you to decide.
>
> *Moving:* In this task, we would like you to imagine that you are planning to move to a new home in a foreign land. Over the next few months, you'll need to locate and purchase a new home and transport your belongings. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in accomplishing this task. Some of the words may be relevant and others may not—it's up to you to decide.

The word stimuli were presented one at a time in a central location on the screen for 5 s each (with an interstimulus interval of 1 s). Subjects were asked to rate each word on a 5-point scale with 1 indicating *totally irrelevant* and 5 indicating *totally relevant*. The rating scale was presented below each word, and subjects made their ratings by pressing the appropriate number key on the keyboard. They were instructed to respond within the 5 s that each word was on the screen, and the word remained on the screen for the full 5 s regardless of when the rating was made. Subjects were not informed of the upcoming memory test. Five practice words were always presented first followed by the 32 words from the main list.

Following the word-rating task, subjects played a Tetris video game for 2 min after which they were given a blank sheet of paper and asked to recall as many of the words as they could from the earlier rating task. The free recall test lasted for 10 min, and subjects were instructed to write down their responses in any order they wished. At the end of the experiment, subjects were debriefed and thanked for their participation.

Results

All results, unless otherwise stated, were significant at the .05 level. Pairwise comparisons were Bonferroni-corrected to the .05 level.

Free recall. The leftmost panel of Figure 1 shows the proportion correct on the free recall test as a function of type of processing condition. As expected, recall was significantly higher in the

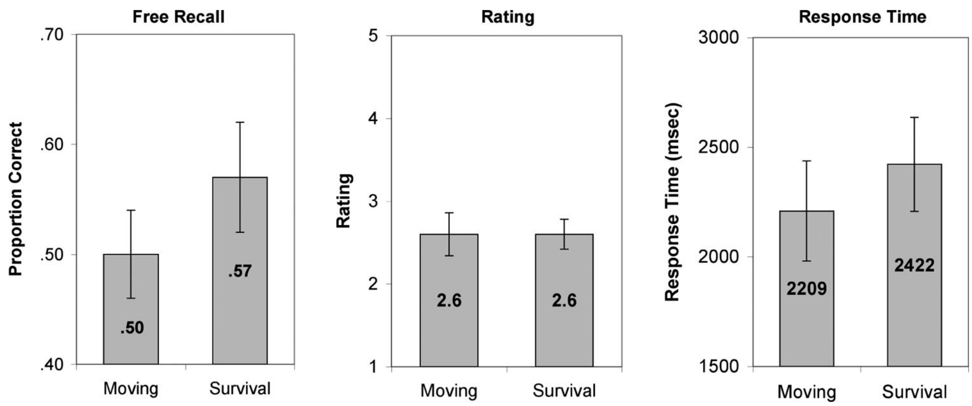

Figure 1. Performance in Experiment 1 as a function of type of processing condition. The three panels represent proportion correct on the free recall test, mean rating, and mean reaction time, respectively. Error bars indicate 95% confidence intervals.

survival processing condition relative to the moving processing condition, .57 vs. .50; $t(38) = 2.30$, standard error of the difference (SED) = .03, $d = 0.66$.

Ratings. The middle panel of Figure 1 shows the mean rating as a function of processing condition. Critically, there was no significant difference in mean rating between the moving processing and the survival processing conditions, 2.59 vs. 2.56; $t(38) = 0.17$, $SED = .16$, $p = .87$.

Response times. The rightmost panel of Figure 1 shows the mean response time as a function of type of processing condition. Although subjects in the survival processing conditions tended to take slightly longer to respond, there was no significant difference in mean response time between the two conditions, 2,422 vs. 2,209; $t(38) = 1.37$, $SED = 155.11$, $p = .18$.

Conditional analyses. The data were further analyzed to determine whether items that subjects rated as being more relevant to the scenario were better remembered. Table 1 shows the proportion of words correctly recalled on the free recall test as a function of initial rating and type of processing condition. Overall, the proportion of words recalled increased as initial rating increased, replicating the congruity effect that Nairne et al. (2007) reported. A 5 (initial rating: 1, 2, 3, 4, 5) × 2 (type of processing: moving processing, survival processing) mixed analysis of variance (ANOVA) confirmed the significant linear trend, $F(1, 34) = 46.22$, mean squared error (MSE) = .051, $\eta_p^2 = .58$.[1] Looking more closely, this congruity effect was also present in both the moving processing and the survival processing conditions. Two additional ANOVAs confirmed significant linear trends in the moving processing condition, $F(1, 19) = 43.64$, $MSE = .04$, $\eta_p^2 = .70$, and the survival processing condition, $F(1, 15) = 11.29$, $MSE = .06$, $\eta_p^2 = .43$. Of course, survival and moving processing conditions cannot be compared for words in each level of rating, because the comparison would be compromised by item-selection effects; different items are in the different rating conditions for the two scenarios.

Discussion

In Experiment 1, we succeeded in replicating the survival processing effect: Survival processing produced superior retention on the free recall test relative to moving processing. It is important to note that there was no significant difference in mean rating or response time between the two conditions. The conditional analyses showed a congruity effect: Words given a higher rating during the processing task were better recalled on the subsequent test. This congruity effect was present in both the moving and survival conditions. The results in Table 1 also suggest that survival processing produced substantially better retention than moving processing for items given ratings of 1 and 4, but not the other conditions. However, as noted earlier, this observation is compromised because the conditional nature of the analysis results in probable item-selection artifacts that cloud any interpretation. We addressed the issue of congruity in Experiment 2 by manipulating the match between materials and mode of processing under conditions in which item selection is not an issue.

Experiment 2

In almost all of their published experiments, Nairne and colleagues have constructed word lists by randomly selecting words from various norms (e.g., Van Overschelde, Rawson, & Dunlosky, 2004). No attempt was made to select words that were relevant to any particular encoding task. Kang et al. (2008) and Weinstein et al. (2008) similarly used lists of randomly selected words. To further explore congruity effects in the survival processing paradigm without the issue of item-selection artifacts, in Experiment 2 we manipulated the congruence between the type of processing and the to-be-encoded words while equating other characteristics of the words.

The procedure was the same as in Experiment 1 except for a few changes. First, we replaced the moving scenario with a bank robbery scenario used previously by one of the authors (Kang et al., 2008) because we already had a normed list of words that were highly relevant to this scenario (see Materials and Counterbalancing in the Method section). Second, we used three different lists of words in which each word was either relevant to the grasslands survival scenario (survival list), relevant to the bank robbery scenario (robbery

[1] Four subjects were excluded from the conditional analyses because they did not use the entire rating scale and therefore did not produce a mean proportion recall for one of the rating levels.

Table 1
Proportion of Words Correctly Recalled on the Free Recall Test in Experiment 1 as a Function of Initial Rating and Type of Processing Condition

	Rating					
Scenario	1	2	3	4	5	Mean (Total)
Moving	.36 (221)	.49 (121)	.53 (95)	.53 (103)	.74 (100)	.50 (640)
Survival	.49 (209)	.56 (120)	.51 (127)	.69 (104)	.73 (80)	.57 (640)
Mean	.43 (430)	.52 (241)	.52 (222)	.61 (207)	.73 (180)	.53 (1,280)

Note. The number of items given each rating is in parentheses.

list), or irrelevant to both scenarios (irrelevant list). The presentation of the words was blocked by list, and list order was counterbalanced across subjects. Subjects in both the survival processing condition and the robbery processing condition rated all three lists of words and then tried to recall words from all three lists.

We predicted that performance on the final free recall test would be highest in the two conditions in which there was congruence between the type of processing and the type of list but that survival processing would produce a larger congruity effect (i.e., that the survival processing–survival list condition would yield greater recall than the robbery processing–robbery list condition). If a robust survival processing effect emerges with a list of randomly selected words, then the effect should still hold or perhaps even increase in magnitude if the words used are congruent with the survival scenario. In addition, we predicted a survival processing advantage for words in the irrelevant list as well.

Method

Subjects. Subjects were 48 undergraduate psychology students at Washington University in St. Louis who participated for course credit.

Design. We used a 3 (type of list: survival, robbery, irrelevant) × 2 (type of processing: survival processing, robbery processing) mixed factorial design. Type of list was manipulated within-subjects and type of processing was manipulated between-subjects with 24 subjects in each condition.

Materials and counterbalancing. The stimuli consisted of three lists of 15 words (45 words total). One list consisted of words relevant to the survival scenario, another list consisted of words relevant to the robbery scenario, and a third list consisted of words that were irrelevant both scenarios. We established the relevance of each word to a particular scenario in a pilot experiment by having a separate group of subjects ($N = 20$) rate all the words with respect to the two scenarios (see the Appendix for the three lists of words and average ratings). In addition, the words in the three lists were matched for frequency ($M = 90$; Kucera & Francis, 1967), length ($M = 5.2$ letters), and imageability ($M = 554$; Coltheart, 1981). An additional five irrelevant words selected according to the same criteria served as practice words. The order in which the lists were presented was counterbalanced across subjects.

Procedure. The procedure was identical to that of Experiment 1 except for two changes. First, subjects rated three different lists of words (survival, robbery, and irrelevant) and the presentation of the words was blocked by list. Second, the instructions for the survival scenario were the same as described previously, but the moving scenario was replaced by a bank robbery scenario from Kang et al. (2008). The instructions for the bank robbery scenario were as follows:

> In this task, we would like you to imagine that you are leading a heist of a well-guarded bank. Over the next few months, you'll need to find people to help you, make a plan, and gather any supplies you might need. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this robbery situation. Some of the words may be relevant and others may not—it's up to you to decide.

Results

Free recall. Figure 2 shows the proportion of words correctly recalled on the free recall test as a function of type of list and type of processing. As predicted, recall performance was highest in the two conditions for which type of processing was congruent with the type of list. In the survival processing condition, the proportion of the survival list recalled was significantly higher than that of the robbery list, .61 vs. .40; $t(23) = 6.2$, standard error of the mean (SEM) = .033, $d = 1.27$, which in turn was higher than the irrelevant list, .40 vs. .33; $t(23) = 2.5$, $SEM = .027$, $p = .06$, $d = 0.52$, but the latter effect was only marginally significant by

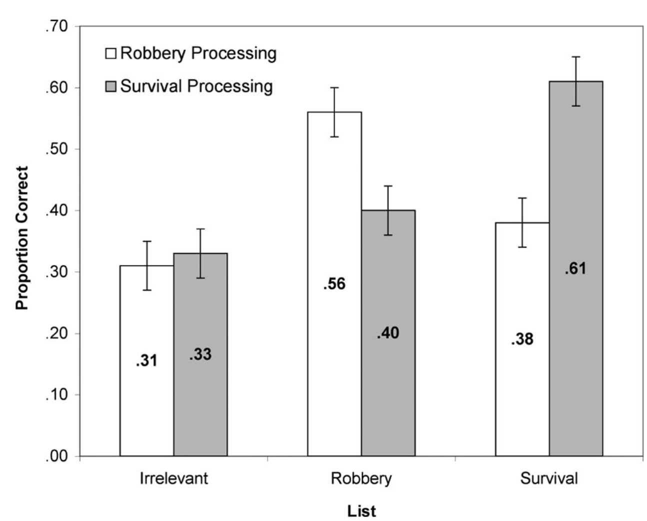

Figure 2. Proportion of words correctly recalled on the free recall test in Experiment 2 as a function of type of list and type of processing condition. Error bars indicate 95% confidence intervals.

conventional standards. Likewise, in the robbery processing condition, the proportion recall of the robbery list was significantly higher than that of the survival list, .56 vs. .38; $t(23) = 3.8$, $SEM = .048$, $d = 0.77$, which in turn was slightly higher than the irrelevant list, .38 vs. .31; $t(23) = 2.2$, $SEM = .033$, $p = .12$, $d = 0.45$, but the latter effect was not significant.

A 3 (type of list) × 2 (type of processing) mixed ANOVA confirmed these observations. There was a significant main effect of type of list, $F(2, 92) = 28.4$, $MSE = .016$, $\eta_p^2 = .38$, in which words from the robbery and survival lists were better recalled than words from the irrelevant list. Also, type of list interacted with type of processing, $F(2, 92) = 28.45$, $MSE = .016$, $\eta_p^2 = .38$, and this interaction was driven by the congruity effect described previously. Planned pairwise comparisons revealed that the proportion recalled of the irrelevant list did not differ significantly between the survival processing and robbery processing conditions, .33 vs. .31; $t(46) < 1$, $SEM = .040$, $p = .58$, the proportion recalled in the congruent conditions (i.e., survival processing–survival list and robbery processing–robbery list) did not differ significantly, .61 vs. .56; $t(46) < 1$, $SEM = .043$, $p = .34$, and neither did the proportion recalled in the incongruent conditions (i.e., survival processing–robbery list and robbery processing–survival list), .40 vs. .38; $t(46) < 1$, $SEM = .019$, $p = .65$.

Subjects did not produce many extralist intrusions during free recall, and the majority of these intrusions were words from the practice list (even though instructions were given not to recall these items) rather than new words. There was no difference between the survival processing and robbery processing conditions in the mean number of intrusions (1.8 vs. 1.7; $t < 1$).

Ratings and response times. Unfortunately, subjects' ratings and response times were not recorded because of an error in the computer program. We remedied this problem in the next experiment.

Discussion

The results of the recall test were surprising. Only the first part of our prediction was supported: Recall performance was highest in the two conditions for which the type of processing and type of list were congruent. However, survival processing did not produce a recall advantage within the two congruent conditions: There was no significant difference in the proportion of items recalled between the survival processing–survival list condition and the robbery processing–robbery list condition. Also, there was no difference in recall of irrelevant list items between the survival processing condition and the robbery processing condition.

The failure to find a significant benefit of survival processing on recall performance was unexpected. However, we were skeptical that the null finding of Experiment 2 would replicate for two reasons. First, the direction of the recall results favored survival processing, albeit only slightly so for the irrelevant list. Second, we blocked the presentation of words by list during the rating task. This aspect of the procedure may have made the thematic structure of the survival and robbery lists especially salient, which could have influenced recall performance and attenuated the survival processing advantage. The proportion recalled of the incongruent lists (e.g., robbery list in the survival processing condition) was marginally higher than for the irrelevant list, providing some evidence that the categorical nature of the lists (or lack thereof in the irrelevant list) had an impact on recall performance.

Experiment 3

Because of these three issues just listed, we decided to replicate Experiment 2 with two changes: (a) The words from the three lists were randomly intermixed during the rating task to reduce the category salience of the survival and robbery lists, and (b) the error in the computer program was fixed so that ratings and response times were recorded.

Method

Subjects. Subjects were 52 undergraduate psychology students at Washington University in St. Louis who participated for course credit. Two subjects were excluded from the experiment because they did not follow directions, which left 25 subjects in each condition.

Design. The design was the same as Experiment 2.

Materials and counterbalancing. The materials were the same as Experiment 2.

Procedure. The procedure was the same as Experiment 2 except for two changes. First, the three lists of words (survival, robbery, and irrelevant) were randomly intermixed in a single list, so subjects only rated one list of 45 words. Second, the computer program was modified to collect rating and response time data.

Results

Free recall. Figure 3 shows the proportion of words correctly recalled on the free recall test as a function of type of list and type of processing. Again, recall performance was highest in the two conditions for which type of processing was congruent with the type of list. In the survival processing condition, a higher proportion of words from the survival list was recalled relative to the proportion of words recalled from either the robbery list, .57 vs. .38; $t(24) = 5.1$, $SEM = .038$, $d = 1.01$, or the irrelevant list, .57 vs. .37; $t(24) = 7.9$, $SEM = .026$, $d = 1.54$. Similarly, in the robbery processing condition, a higher proportion of words from

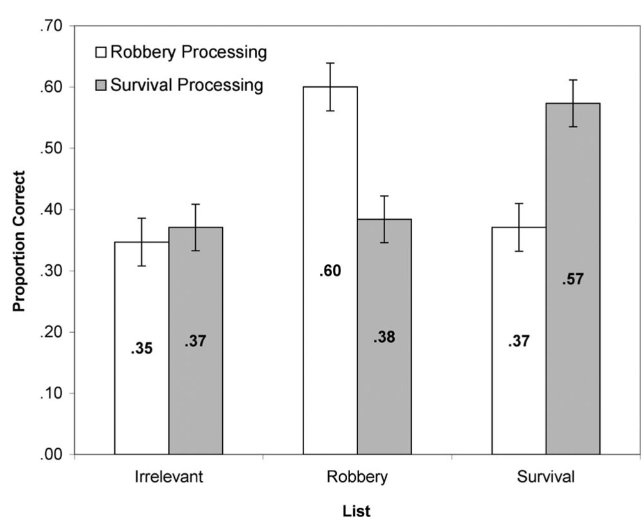

Figure 3. Proportion of words correctly recalled on the free recall test in Experiment 3 as a function of type of list and type of processing condition. Error bars indicate 95% confidence intervals.

the robbery list was recalled relative to words from either the survival list, .60 vs. .37; $t(24) = 7.3$, $SEM = .031$, $d = 1.47$, or the irrelevant list, .60 vs. .35; $t(24) = 8.7$, $SEM = .029$, $d = 1.72$. A 3 (type of list) × 2 (type of processing) mixed ANOVA confirmed these observations. There was a significant main effect of type of list, $F(2, 96) = 19.9$, $MSE = .013$, $\eta_p^2 = .29$, in which words from the robbery and survival lists were better recalled than words from the irrelevant list. Also, there was a significant interaction between type of list and type of processing, $F(2, 96) = 42.9$, $MSE = .013$, $\eta_p^2 = .47$, which was driven by the congruity effect described earlier.

Several planned pairwise comparisons were also conducted. First, the proportion of words recalled from the irrelevant list for the survival processing and robbery processing conditions did not differ significantly, .37 vs. .35; $t(48) < 1$, $SEM = .030$, $p = .48$. Second, there was no significant difference between the proportion of words recalled in the survival processing–survival list and robbery processing–robbery list conditions, .57 vs. .60; $t(48) < 1$, $SEM = .038$, $p = .49$. Finally, the proportion of words recalled in the survival processing–robbery list and robbery processing–survival list conditions did not differ significantly, .38 vs. .37; $t(48) < 1$, $SEM = .044$, $p = .84$.

As in Experiment 2, subjects did not produce many extralist intrusions during free recall. There was no difference between the survival processing and robbery processing conditions in the mean number of intrusions (2.6 vs. 2.7; $t < 1$).

Ratings. Table 2 shows the mean ratings as a function of type of list and type of processing. The rating data yielded the same general pattern of results as free recall. In the survival processing condition, words from the survival list were given a higher rating than words from either the robbery list, 4.4 vs. 2.1; $t(24) = 27.4$, $SEM = .086$, $d = 5.36$, or the irrelevant list, 4.4 vs. 1.9; $t(24) = 27.4$, $SEM = .092$, $d = 5.45$. Likewise, in the robbery processing condition, words from the robbery list were given a higher rating than words from either the survival list, 4.3 vs. 2.1; $t(24) = 21.1$, $SEM = .104$, $d = 4.24$, or the irrelevant list, 4.3 vs. 1.8; $t(24) = 29.8$, $SEM = .085$, $d = 5.86$. A 3 (type of list) × 2 (type of processing) mixed ANOVA confirmed these observations. There was a highly significant main effect of type of list, $F(2, 96) = 358.5$, $MSE = .091$, $\eta_p^2 = 0.88$, in which words from the robbery and survival lists were rated higher than words from the irrelevant list. Also, there was a significant interaction between type of list and type of processing, $F(2, 96) = 713.0$, $MSE = .091$, $\eta_p^2 = 0.94$. However, there was no difference in overall mean rating between the survival processing and robbery processing conditions (2.8 vs. 2.8, $F < 1$).

Three planned pairwise comparisons were conducted. First, the mean rating for words in the irrelevant list did not differ significantly between the survival processing and robbery processing conditions, 1.9 vs. 1.8; $t(48) = 1.2$, $SEM = .113$, $p = .26$. Second, the mean rating of words in the survival processing–survival list and robbery processing–robbery list conditions did not differ significantly, 4.4 vs. 4.3; $t(48) < 1$, $SEM = .109$, $p = .34$. Finally, there was no significant difference in mean rating between the survival processing–robbery list and robbery processing–survival list conditions, 2.1 vs. 2.1; $t(48) < 1$, $SEM = .123$, $p = .67$.

Response times. Table 2 also shows the mean response times (in milliseconds) for rating words as a function of type of list and type of processing. On average, subjects in the survival processing condition took slightly longer to rate each word in the irrelevant and robbery lists than those in the robbery processing condition, but this pattern was reversed for the survival list. In the survival processing condition, response times were faster for words in the survival list than for words in either the robbery list, 1,983 vs. 2,428; $t(24) = 6.9$, $SEM = 64.6$, $d = 1.38$, or the irrelevant list, 1,983 vs. 2,332; $t(24) = 4.9$, $SEM = 73.0$, $d = 0.96$. In the robbery processing condition, response times were slower for words in the survival list than words in either the robbery list, 2,217 vs. 2,046; $t(24) = 2.1$, $SEM = 83.5$, $d = 0.41$, or the irrelevant list, 2,217 vs. 2,055; $t(24) = 3.0$, $SEM = 54.6$, $d = 0.59$. A 3 (type of list) × 2 (type of processing) mixed ANOVA revealed a significant main effect of list, $F(2, 96) = 4.2$, $MSE = 606{,}677.0$, $\eta_p^2 = .08$, in which the mean response time for words in the robbery list was significantly greater than for words in the survival list. In addition, there was a significant interaction between type of list and type of processing, $F(2, 96) = 22.8$, $MSE = 606{,}677.0$, $\eta_p^2 = .32$. There was no significant difference between the two type of processing conditions, $F(1, 48) = 1.4$, $MSE = 606{,}677.0$, $\eta_p^2 = .24$.

The three planned pairwise comparisons were again conducted for the response time data. First, the mean response time for words in the irrelevant list was significantly greater in the survival processing condition relative to the robbery processing condition, 2,332 vs. 2,055; $t(48) = 2.4$, $SEM = 119.5$, $d = 0.63$. Second, the mean response time did not differ significantly between the survival processing–survival list and robbery processing–robbery list conditions, 1,983 vs. 2,046; $t(48) < 1$, $SEM = 139.4$, $p = .66$. Finally, there was no significant difference in mean response time between the survival processing–robbery list and robbery processing–survival list conditions, 2,431 vs. 2,217; $t(48) = 1.47$, $SEM = 145.4$, $p = .15$. Relating response time to proportion recalled across the six conditions showed that no positive corre-

Table 2
Mean Rating, Mean Response Times, and Standard Errors of the Mean From Experiment 3 as a Function of Type of List and Type of Processing Condition

	Rating				Response time (ms)			
	Robbery		Survival		Robbery		Survival	
Type of list	*M*	*SEM*	*M*	*SEM*	*M*	*SEM*	*M*	*SEM*
Robbery	4.3	0.09	2.1	0.07	2,046	103.5	2,428	112.4
Survival	2.1	0.10	4.4	0.06	2,217	92.2	1,983	93.2
Irrelevant	1.8	0.09	1.9	0.07	2,055	79.6	2,332	89.0

lation exists between response time and recall. In fact, for the robbery and survival items, response times were faster in the congruent conditions that led to better recall on the later test.

Discussion

The results of Experiment 3 replicated those of Experiment 2. Performance on the free recall test was highest in the survival processing–survival list and robbery processing–robbery list conditions in which there was congruity between the type of processing and type of list. However, there was again no difference in free recall performance between survival processing and robbery processing for words from the irrelevant list, nor was there a difference between the two conditions in which type of processing and type of list were congruent (i.e., the survival processing–survival list and robbery processing–robbery list conditions). The results of the rating task, which were not available for Experiment 2, mirrored those of the free recall test: Congruent words were rated as more relevant than incongruent words, but there was no difference in the mean ratings between the two processing conditions for either the irrelevant, congruent, or incongruent lists. The response time results showed several significant differences between the various conditions; however, these differences usually showed longer mean response times for the survival processing condition (e.g., for the robbery and irrelevant lists), which should favor survival processing and therefore cannot explain the absence of the predicted survival processing effect in free recall.

One possible explanation for the lack of a survival processing advantage in Experiments 2 and 3 is that there was output interference during the final recall test. That is, subjects may have first recalled stronger schema-relevant items (i.e., items from the survival list in the survival processing condition and items from the robbery list in the robbery processing condition), thereby interfering with or suppressing retrieval of irrelevant items. In order to examine the possibility of output interference, we broke down the data from the final recall test as a function of output order by Vincentizing (see Vincent, 1912, or, more recently, Ratcliff, 1979) the words recalled by each subject into quartiles. That is, the words recalled by each subject were divided into four groups of equal numbers of items in terms of output order. Figure 4 shows the cumulative proportion of items recalled as a function of output quartile and type of list for the robbery processing (top panel) and survival processing (bottom panel) conditions. Although recall of the congruent list was higher in both processing conditions, the proportion of items recalled for all three types of lists increased steadily across the quartiles. Critically, the proportion of items recalled for each list did not differ much as a function of output quartile; approximately one quarter of the total items recalled from each list was produced in each the quartile, and this pattern held across all three list types in both processing conditions. Thus, the analysis of output order does not support the idea that the failure to find a survival processing advantage was somehow due to output interference.

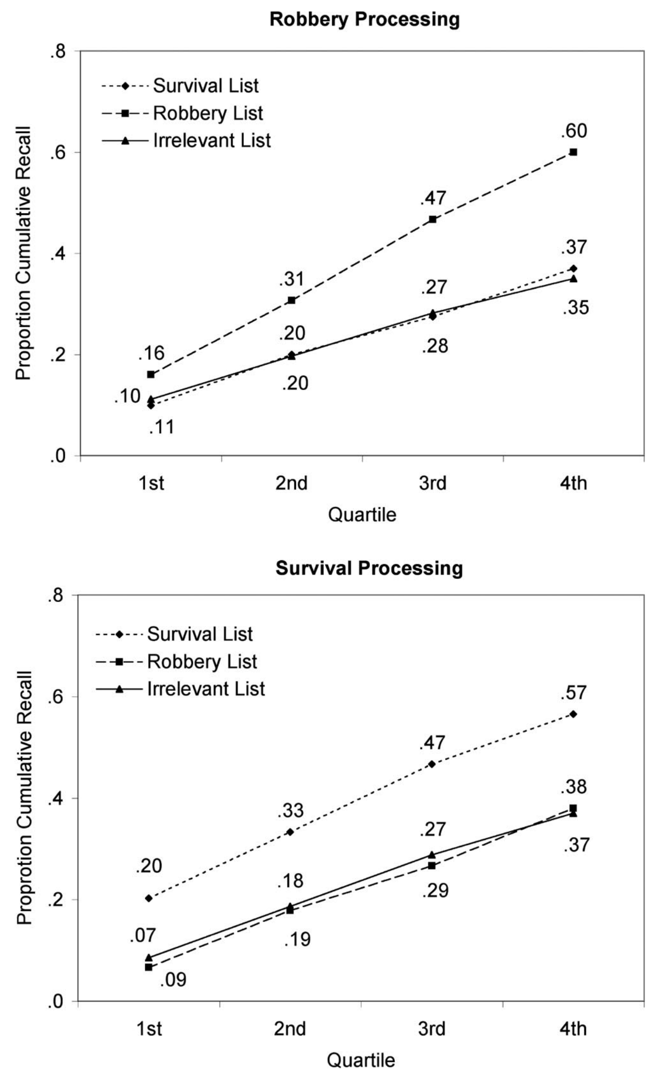

Figure 4. The cumulative proportion of items recalled as a function of output quartile and type of list for the robbery processing (top panel) and survival processing (bottom panel) conditions.

General Discussion

The present research represents an initial attempt to investigate congruity effects within the survival processing paradigm (Nairne et al., 2007). In Experiment 1, we replicated the findings of Nairne et al. (2007) and other research by showing the survival processing effect as well as a congruity effect using a randomly selected list of words. Experiments 2 and 3 used materials selected for various semantic qualities that were relevant or irrelevant to the survival and robbery scenarios and showed robust congruity effects; word lists that were congruent with the processing task were well recalled, and those that were incongruent were recalled less well. In fact, when the materials were controlled with respect to congruence between processing and words, no survival processing advantage was observed for either the highly congruent list items or the irrelevant list items.

The results of the three experiments support the idea that congruity effects are robust and important phenomena. Although such effects are well documented in the levels-of-processing literature (e.g., Craik, 1973; Moscovitch & Craik, 1976), researchers have struggled to explain why they occur within the levels-of-processing framework (see Lockhart & Craik, 1990; Roediger & Gallo, 2002). As discussed earlier, various proximate mechanisms have been suggested over the years, such as greater *elaboration* (Schulman, 1974) or better *semantic integration* (Craik & Tulving, 1975) during encoding.

Despite some discussion of congruity effects in the literature on the levels-of processing effect, the general significance of congruity effects has been overlooked in the field. Nairne and his colleagues represent an exception to this claim, because they are clearly aware of the importance of context and congruity and allude to these issues several times in their articles. For example, Nairne et al. (2007) wrote, "Thus, the survival value of an item depends very much on the context in which that item is encountered . . . a pencil is not inherently related to survival, although it might be in a context in which it could be used as a weapon or a device for writing a note that secured freedom or food" (p. 270). Likewise, Nairne and Pandeirada (2008a) stated, "Is there an s-value (survival-value) associated with a stimulus that predicts its memorability in the same way that imageability (concreteness) or word frequency predict retention? Perhaps, but survival relevance is likely to be context-dependent" (p. 240). Nevertheless, their primary point was that survival processing produces superior retention relative to other processing tasks, and this effect is independent of the nature of the stimuli. Thus, they argued that a survival processing advantage should be observed for material regardless of whether it is congruent or incongruent with (or relevant or irrelevant to) the way in which it is being processed.

If survival processing is so critical, why did it fail to produce the same mnemonic advantage in Experiments 2 and 3 that it did in Experiment 1 and in previous studies? One potential explanation revolves around the nature of the materials used. In Experiments 2 and 3, we used lists of words that were selected on the basis of their congruence with the two types of processing tasks so that we could manipulate congruence between processing task and materials (and so we could equate item sets on some other characteristics known to affect memorability). In contrast, in almost all of the published studies in which a survival processing effect has been found, investigators have used randomly selected lists of words in which congruence between processing task and materials was left to vary in an unconstrained manner. It may be that randomly selected lists of words often contain a greater number of words that are congruent with the survival processing scenario than other processing tasks (e.g., "planning a zoo party"). On the other hand, it is hard to believe that such an item-selection artifact could be present in the several different random lists that have been used in prior work. Clearly, further research needs to be conducted with a wide variety of types of items such as pictures and categorized lists, as well as content-specific materials such as those related to food, predators, reproduction, and other survival-relevant domains.

Still, there is some evidence from Nairne's laboratory, of which we were unaware prior to beginning our research, to support the idea that congruity between processing and materials plays a role in the survival processing effect. In an unpublished study, Ceo and Nairne (2007, Experiment 2) identified words that had been previously rated as either highly relevant to the survival scenario (high s-value words) or irrelevant (low s-value words). Subjects rated these words, which were presented in a randomly intermixed list, with respect to either the survival scenario or pleasantness. The results showed that survival processing (M = .63) led to significantly greater recall relative to pleasantness (M = .45) for the high s-value words, but no significant difference between the two conditions occurred for the low s-value words (means of .46 and .42, respectively). Presumably, the high s-value words produced a significant survival processing advantage over pleasantness because they were highly congruent with the survival scenario relative to the pleasantness rating task.

After reading an earlier version of our article, Nairne and colleagues (J. S. Nairne, personal communication, November 2008) collected some unpublished data showing that a survival processing advantage can be found when congruence between processing and materials is controlled. Using pure lists of words that were either highly relevant or highly irrelevant to the robbery and survival processing scenarios, they found that survival processing produced better retention than robbery processing. One possible explanation is that the lack of a survival processing effect in our experiments and in Ceo and Nairne's (2007; Experiment 2) study with low s-value words may be the result of using mixed lists of words rather than pure lists. However, in Experiment 2 in the present study, we did use a block list design in which the words were presented to subjects in pure list form (albeit with other item types presented in separate pure lists), but a survival processing effect still failed to emerge. Of course, mixed lists that contain both high- and low-relevance words are more similar to the random lists of words used in most of the experiments in which the survival processing effect has been found. Certainly, more research is needed to determine the boundary conditions for the survival processing effect. Nevertheless, the results of Experiments 2 and 3 (and Ceo & Nairne, 2007) suggest that when the materials are carefully controlled with respect to congruence between type of processing and the nature of materials used, survival processing does not always produce superior recall.

In one sense, our results complicate the interpretation of previously published research on the survival processing effect (e.g., Nairne et al., 2007), but in a broader view, we see our research as consistent with a functional approach to studying memory. Congruity effects can be understood from a functional hypothesis in which memory systems are tuned to encode and retrieve information relevant to the purpose or goal at hand. Recall or recognition of material is better when that material is relevant to or congruent with the goals of processing and with the processes required for retrieval. Thus, the outcome of our experiments is broadly consistent with the ideas of the encoding specificity hypothesis (Tulving, 1983) and the transfer appropriate processing framework (Morris, Bransford, & Franks, 1977; Roediger, Weldon, & Challis, 1989).

We believe that the work of Nairne and his colleagues (2007, 2008), as well as that of others (e.g., Klein, Cosmides, Tooby, & Chance, 2002), has reintroduced a critical emphasis on functional approaches to experimental research and how such approaches can yield interesting and testable hypotheses (see too Nairne, 2005). We suggest that the congruity of goals active during processing, the types of materials to which processing is directed, and the retrieval processes required to use the stored information must be part and parcel of such functional considerations.

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Appendix

The Three Lists of Words (Robbery, Survival, and Irrelevant) Used in Experiments 2 and 3

	Average rating		Characteristics		
List/word	Survival	Robbery	Length	Frequency	Imageability
Robbery					
Account	1.0	4.0	7	117	361
Alarm	1.7	4.7	5	16	—
Car	2.1	4.9	3	278	638
Case	2.4	4.3	4	370	517
Clerk	1.0	4.7	5	34	—
Code	1.3	4.9	4	41	299

(*Appendix continues*)

Appendix (*continued*)

List/word	Average rating: Survival	Average rating: Robbery	Characteristics: Length	Characteristics: Frequency	Characteristics: Imageability
Computer	1.4	4.6	8	13	—
Deposit	1.1	4.0	7	9	413
Door	1.1	3.9	4	321	599
Mask	1.9	4.6	4	9	555
Telephone	2.0	3.7	9	77	655
Vault	1.0	4.9	5	2	550
Window	1.0	4.1	6	120	602
Wire	1.3	4.1	4	46	562
Witness	1.1	4.7	7	28	467
Mean for list	1.4	4.4	5.5	99	518
Survival					
Blanket	4.7	1.1	7	31	582
Earth	3.9	1.1	5	159	580
Fire	3.7	1.7	4	205	634
Fruit	4.7	1.0	5	35	587
Lion	3.7	1.0	4	17	626
Milk	3.9	1.0	4	49	626
Outside	4.1	1.7	8	209	419
Plant	3.9	1.3	5	128	617
Rain	4.0	1.3	4	71	618
Rescue	4.9	1.4	6	15	456
River	3.9	1.0	5	165	608
Shelter	4.7	1.7	7	70	488
Tent	4.0	1.0	4	20	593
Tree	4.1	1.6	4	62	644
Wood	4.1	1.0	4	60	577
Mean for list	4.1	1.3	5.1	86	577
Irrelevant					
Couch	1.1	1.0	5	13	511
Flute	1.0	1.0	5	1	581
Girl	1.6	1.7	4	225	634
Horn	1.9	1.3	4	33	566
Husband	1.3	1.0	7	133	537
Inch	1.0	1.6	4	97	472
Jazz	1.0	1.0	4	105	551
Nation	1.1	1.6	6	151	436
Picture	1.0	1.6	7	168	581
Rake	1.6	1.0	4	11	550
Soccer	1.1	1.0	6	3	570
Spoon	1.6	1.0	5	6	584
Student	1.1	1.1	7	136	603
Table	1.1	1.7	5	204	582
Tulip	1.3	1.0	5	5	632
Mean for list	1.3	1.2	5.2	86	559

Note. The relevance of each word was rated with respect to the survival and robbery scenarios in a pilot experiment (N = 20). Mean rating with respect to each scenario, word length, word frequency (Kucera & Francis, 1967), and imageability (Coltheart, 1981) are listed for each word.

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