Semantic Congruency Facilitates Memory for Emojis

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Abstract

Emojis can assume different relations with the sentence context in which they occur. While affective elaboration and emoji-word redundancy are frequently investigated in laboratory experiments, the role of emojis in inferential processes has received much less attention. Here, we used an online ratings task and a recognition memory task to investigate whether differences in emoji function within a sentence affect judgments of emoji-text coherence and subsequent recognition accuracy. Emojis that function as synonyms of a target word from the passages were rated as better fitting with the passage (more coherent) than emojis consistent with an inference from the passage, and both types of emojis were rated as more coherent than incongruent (unrelated) emojis. In a recognition test, emojis consistent with the semantic content of passages (synonym and inference emojis) were better recognized than incongruent emojis. Findings of the present study provide corroborating evidence that readers extract semantic information from emojis and then integrate it with surrounding passage content.

1 Emojis and Word Processing

Recent research using both ratings tasks and online processing measures has shown that emojis that are redundant (i.e., synonymous) with a target word can facilitate text comprehension (Daniel and Camp, 2020). Barach and colleagues (Barach et al., 2021) used eye tracking measures to examine how readers benefit from the presence of non-face emojis that were positioned at the end of sentences and were synonymous with the target word (e.g., coffee). They compared sentences with emojis that were either semantically congruent with the target word (e.g., "My tall coffee is just the right temperature ☕"), semantically incongruent (e.g., "My tall coffee is just the right temperature 🍺"), and sentences without an emoji ("My tall coffee is just the right temperature"). Participants in their experiment read the sentences for comprehension while their eye movements were recorded. The congruent emojis were skipped more often and fixated for less time than the incongruent emojis, and the overall sentence reading times were shorter when the emojis were congruent compared to incongruent with the proceeding text. These effects of semantic congruency reported by Barach and colleagues (Barach et al., 2021) suggest that, similar to semantic congruency effects with words, readers extract semantic information from emojis and integrate it with the surrounding text. Similar findings were shown when text includes face emojis, which can convey more subtle and less literal meanings than non-face emojis (Beyersmann et al., 2022), and when emojis were used to replace words in sentences (Cohn et al., 2018; Scheffler et al., 2022; Weissman, 2019).

2 Emojis and Higher-Level Language Processing

In contrast to the research summarized above that examined linguistic processing of emojis associated with the meaning of isolated words, other studies have examined how readers process sentences with emojis that cannot be mapped to a single word, such as the detection of sarcastic intent (Garcia et al., 2022; Weissman and Tanner, 2018) and other types of indirect messages that go beyond the literal meaning of a statement (Holtgraves and Robinson, 2020).

Both behavioral and neurophysiological measures indicate that a winking face emoji invites sarcastic and ironic interpretations during reading (Garcia et al., 2022; Weissman and Tanner, 2018). For example, accuracy in detecting sarcastic intent increased when a winking face emoji was present, demonstrating that the presence of an emoji can promote sarcastic relative to more literal sentence interpretations (Garcia et al., 2022).

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In addition to sarcasm, the presence of an emoji can disambiguate other indirect aspects of sentence meaning. Holtgraves and Robinson (Holtgraves and Robinson, 2020) had participants read a series of questions followed by indirect replies that either contained an emoji (e.g., a worried face) or did not contain an emoji. For disclosures (e.g., “How did you do in chemistry?”) and opinions (e.g., “What did you think of my presentation?”), but not requests for actions (e.g., “Can you type my term paper for me?”), judgements about whether a reply was congruent with the intent of the question were more accurate and faster when the reply contained an emoji than when it did not. Collectively, these findings provide evidence that emojis can help to offset a discrepancy between literal and nonliteral aspects of meaning, often associated with grasping a speaker’s intent.

3 Memory for Emojis in Text

In contrast to the comprehension effects delineated above, only two studies have examined effects of emojis on memory (Chatzichristos et al., 2020; Homann et al., 2022). Chatzichristos and colleagues (Chatzichristos et al., 2020) provided evidence that emojis can influence memory for autobiographical events during reading. Participants in this study completed a retrieval task for autobiographic memories cued by a word paired either with a positive or a negative face emoji. Emotional incongruity of word-emoji pairs led to longer reaction times for retrieval as well as enhanced activation in brain areas associated with language-induced semantic conflict, suggesting that emoji affect influenced memory retrieval.

To examine how memory for emojis differs from memory for words, Homann and colleagues (Homann et al., 2022) compared isolated words or emojis under full attention and under divided attention conditions. In the divided attention condition, participants recalled the previously studied stimuli while completing a distractor 1-back recall task with one of three types of materials (i.e., words, emojis, and shapes). In that study, recall performance was better for isolated emojis than for words. In addition, recall memory for words was more disrupted when the simultaneous distractor task involved words, whereas declines in recall accuracy were smaller when the distractor task involved emojis. However, emoji recall was equally good when a distractor task involved emojis, words, or shapes. The authors concluded that because emojis have not only verbal but also distinctive visuo-spatial attributes, they interfere less with memory for single words and for each other than do words. The findings by (Chatzichristos et al., 2020) suggest that emojis impact memory retrieval, and the findings by (Homann et al., 2022) suggest that the combination of both verbal and visuo-spatial attributes of emojis makes them easier to recall in memory than words.

The levels of processing framework proposes that semantic elaboration results in stronger memory traces than shallower processing (Craik and Lockhart, 1972), therefore, memory can be enhanced for content that is semantically congruent with surrounding context (e.g., (Packard et al., 2017)). The classic finding is that when participants are instructed to process single words for form (shallow processing) as compared with for meaning (deep processing), encoding for deep level processing takes longer but, importantly, recall accuracy is higher (Craik and Tulving, 1975). Typically, comparisons of processing depth for recognition memory have been demonstrated for single words (Craik and Tulving, 1975). Researchers have yet to examine memory for emojis whose integration with text requires different degrees of semantic processing.

Central to the present study, we understand inferential processing to entail a deeper level of semantic analysis than the semantic processing of isolated words (Mason and Just, 2004) and we ask whether memory can be modulated by emoji-induced elaborations on critical regions of a sentence (Sanford et al., 2006). Precisely aligned stress on critical words in speech (Fraundorf et al., 2010), or italicizing or bolding in text (Sanford et al., 2006), can signal focus. Here we assume that emojis can provide a similar marker of focus and we ask whether memory for emojis may differ depending on whether the emoji-text relation supports shallower (word substitution) or deeper (inference) processing.

4 Present Study

Whereas prior work has often focused on the impact of substituting a word for an emoji, the current study instead presents the text and emoji at the same time to explore how readers integrate emojis with the preceding context. The present study examined emoji-text coherence and recognition memory for emojis whose function supports either a

Emoji Condition	**Passage**
Congruent Inference	Bobby brought home a new pet to live in the tank. He hoped he would remember to buy some mice to feed it on his way home from basketball practice the next night. 🐍
Congruent Synonym	Bobby brought home a new pet to live in the tank. He hoped he would remember to buy some mice to feed it on his way home from basketball practice the next night. 🏀
Incongruent	Bobby brought home a new pet to live in the tank. He hoped he would remember to buy some mice to feed it on his way home from basketball practice the next night. ⚖️

Table 1: Sample stimuli. The target word in this example is underlined.

lower- or higher-level analysis of passage meaning. We predicted that emojis consistent with passage content (congruent synonym and congruent inference emojis) would have higher coherence as measured by fit ratings than the emojis we selected to be irrelevant to the passages (incongruent emojis). Based on the levels of processing framework and prior work showing that readers show semantic congruency effects for emojis during reading (Barach et al., 2021; Beyersmann et al., 2022), we predicted that readers would show higher recognition accuracy for emojis that are congruent with the surrounding passage content (synonym and inference emojis) than incongruent emojis. Extrapolating from the levels of processing framework (Craik and Lockhart, 1972), we also hypothesized a memory advantage for emojis consistent with passage inferences, such that readers would show higher recognition accuracy for inference emojis than for synonym emojis.

4.1 Participants

Participants consisted of 89 undergraduate students at a large university in the northeast United States who completed the study for course credit.

4.2 Materials

Sixty short passages were created for the present study. Some passages were modified from materials of (Virtue and Motyka Joss, 2017). All passages consisted of two sentences and an emoji. Both sentences contained cues to an inference, and the second sentence included an elaboration about a target word. Each passage was paired with three non-emotion, object emojis: 1) an emoji consistent with the inference (congruent inference), 2) an emoji consistent with the meaning of a target word within the passage (congruent synonym), and 3) an emoji that was irrelevant to the passage (incongruent). Emojis were always positioned at the end of the passage, and no emoji appeared in more than one sentence context. See Table 1 for sample stimuli.

4.3 Procedure

Participants completed one of six counterbalanced versions of an online Qualtrics survey with two parts (rating, recognition). Versions were counterbalanced on emoji condition (congruent synonym, congruent inference, incongruent) in the ratings task, and on whether the emoji item was old or new in the subsequent recognition task. For each participant, ten passages were paired with a congruent synonym emoji, a different ten passages were paired with a congruent inference emoji, and a third set of ten passages was paired with an incongruent emoji. Participants first completed a ratings task in which they were shown 30 passages with an emoji. One passage was displayed per page, and for each passage, participants rated how well the emoji fits with the passage by choosing among five choices, “Not well at all”, “Slightly well”, “Moderately well”, “Very well”, “Extremely well”. After the emoji ratings task, participants completed a demographics questionnaire. Then, participants completed a recognition memory task with 60 emojis, half of which had appeared in the rating task. For each trial in the recognition task, participants were shown an emoji and were asked to make an old/new judgment, to indicate whether they had seen the emoji paired with a passage in the rating task (i.e., old) or if the emoji had not been previously presented (i.e., new).

5 Results

Data from 23 participants who had low recognition accuracy (i.e., below 60% accuracy) were removed from the dataset. After removal, the dataset consists of data from 66 participants.

5.1 Emoji-Text Coherence

A linear mixed-effect model was performed using the lme4 package in R (Bates et al., 2015) to examine emoji-text coherence ratings between the three emoji conditions. Measures of emoji-text coherence were based on participants' judgments of emoji fit with the accompanying passage based on a five-point scale, and fit judgments were converted to numeric ratings (5 = high coherence). Mean coherence ratings differed as a function of the relation of the emoji to passage (emoji condition), $F(2, 1866.5) = 921.45$, $p < .001$. Pairwise comparisons showed that participants provided higher coherence ratings for congruent inference emojis than incongruent emojis ($t(1876) = 32.45$, $p < .001$, $d = 1.67$), and higher coherence ratings for congruent synonym emojis than incongruent emojis ($t(1869) = 40.56$, $p < .001$, $d = 2.25$). Finally, participants judged congruent synonym emojis to be more coherent than congruent inference emojis ($t(1869) = -8.09$, $p < .001$, $d = .35$). Table 2 summarizes emoji-text coherence based on mean ratings of fit and standard error for each emoji condition.

5.2 Emoji Recognition Accuracy

A logistic mixed-effect model was performed using the lme4 package in R (Bates et al., 2015) to examine the effect of emoji condition on recognition accuracy for emojis that had been previously presented in passages for coherence judgments. Mean recognition accuracy significantly differed as a function of emoji condition, ($\chi^2 = 15.90$, $p < .001$). Pairwise comparisons showed that participants had higher recognition accuracy for inference emojis compared to incongruent emojis ($z = 3.88$, $p <.001$, $d = .23$) and participants had higher recognition accuracy for synonym emojis compared to incongruent emojis ($z = 2.41$, $p = .02$, $d = .11$). Recognition accuracy was numerically, but not significantly, higher for inference emojis compared to synonym emojis ($z = 1.71$, $p =.09$, $d = .12$). Table 2 shows mean recognition accuracy (i.e., proportion correct for old emoji items) and standard error for each emoji condition.

Emoji Condition	**Emoji-Text Coherence (Fit Ratings)**	**Recognition Accuracy (Proportion Correct)**
Congruent Inference	3.12 (.05)	.90 (.01)
Congruent Synonym	3.56 (.05)	.86 (.01)
Incongruent	1.30 (.03)	.82 (.01)

Table 2: Mean emoji-text coherence ratings and mean recognition accuracy for old emojis. Standard error in parentheses.

6 Discussion

The goal of the present study was to examine emoji-text coherence and recognition memory for emojis that appear in passage-final position and relate to passages in one of three ways. With respect to judgments of coherence, readers judged congruent emojis (synonym and inference emojis) as better fitting with the passages than incongruent emojis. In addition, readers judged synonym emojis as better fitting with the passages than inference emojis.

With respect to recognition accuracy, results show that, consistent with the levels of processing framework, readers had more accurate recognition memory for emojis that were semantically relevant to the paired text compared to emojis that were not related to the text, suggesting that readers encoded the semantic content of the emojis and integrated it with the surrounding text. The present study extends previous findings suggesting that readers show semantic congruency effects in online processing measures (Barach et al., 2021; Beyersmann et al., 2022) by providing insight about what is retained in memory shortly after reading passages with emojis. Specifically, our findings suggest that readers encode the semantic properties of emojis in memory and show better recognition of semantically congruent emojis compared to semantically-incongruent emojis after a short delay. Contrary to the degree of semantic elaboration within the levels of processing framework (Craik and Lockhart, 1972), readers showed a numerical, but not a statistically reliable benefit for inference emojis compared to synonym emojis.

6.1 Limitations

The decision to place emojis in passage final position was based on two factors: 1) the evidence that integration processes occur late in comprehension (Kintsch, 1988), and 2) the general tendency for many types of emojis to appear in passage final position (Kwon et al., 2021). A defining characteristic of gestures is that they be precisely coordinated with the relevant message to be maximally effective at enhancing the focus on some elements relative to others (Overoye and Wilson, 2020). If emojis in text function like gestures in speech (Feldman et al., 2017; Gawne and McCulloch, 2019), then emojis of different functions may be easier to remember when they are positioned closer to relevant regions in the text.

6.2 Future Directions

Emoji position influences eye movement behaviors during reading (Feldman et al., 2019; Robus et al., 2020), however, it is unclear how emoji-text relation interacts with emoji position during reading. In the future, we plan to compare eye-tracking measures for the same emoji conditions used in the present study in different positions within passages. This will allow us to examine time-course and spill-over differences across conditions defined by the emoji-text relation. Additionally, future work should examine performance on a more challenging memory recognition task with a longer retention interval and more difficult emoji discrimination, as this approach may magnify the recognition memory effects found in the present study.

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