Using implicit instructional cues to influence false memory induction

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Abstract

Previous research has shown that explicit cues specific to the encoding process (endogenous) or characteristic of the stimuli themselves (exogenous) can be used to direct a reader's attentional resources towards either relational or item-specific information. By directing attention to relational information (and therefore away from item-specific information) the rate of false memory induction can be increased. The purpose of the current study was to investigate if a similar effect would be found by manipulating *implicitly* endogenous cues. An instructional manipulation was used to influence the perceptual action participants performed on word stimuli during the encoding of DRM list words. Results demonstrated that the instructional conditions that encouraged faster processing also led to an increased rate of false memory induction for semantically related words, supporting the hypothesis that attention was directed towards relational information. This finding supports the *impoverished relational processing* account of false memory induction. This supports the idea that implicitly endogenous cues, exogenous cues (like font) or explicitly endogenous cues (like training) can direct attentional resources during encoding.

Keywords: impoverished relational processing, false memory induction, word recognition, visual encoding words

Using implicit instructional cues to influence false memory induction

When we are exposed to information that we will later have to remember, many encoding-specific factors contribute to the quality and strength of the memory trace. For example, if we must memorize a list of words, our memories for the words themselves are influenced by cues exogenous to the encoding process such as word font or color, as well as cues endogenous to the encoding processes, such as being trained to implement specific memory strategies (Arndt & Reder, 2003; Park, Arndt, & Reder, 2006; McCabe, Presmanes, Robertson & Smith, 2004). Endogenous and exogenous cues can also interact during the encoding process, and are hypothesized to encourage distinct attentional processes (Hopfinger & West, 2005). These cues not only influence our memory for the presented list words, but also can reliably influence false memories for semantically related words. By understanding how false memories can be elicited experimentally by manipulating these cues, we can begin to understand how they influence encoding (Loftus, Miller & Burns, 1978; Roediger & McDermott, 1995). The Deese-Roediger-McDermott (DRM) paradigm is a popular paradigm that can be used to elicit and measure false memory induction (Roediger & McDermott, 1995). In this paradigm, participants are presented with a list of thematically related words such as *bed*, *rest*, and *awake*. They then might later wrongfully determine that the critical lure word *sleep* had also been presented (Roediger & McDermott, 1995; Stadler, Roediger & McDermott, 1999). The current study investigated how false memory induction might be affected by manipulating the *way* that participants cognitively process and encode a word list, but doing so without giving explicit training on an encoding strategy. This would therefore be an implicitly endogenous cue.

Implicitly manipulating endogenous encoding cues

We used methodology developed by Dickinson and Szeligo (2008) in this study to implicitly manipulate encoding. These authors demonstrated that by changing only one key word in the instructions for a visual task, participant response times to subsequently presented visual stimuli could be reliably manipulated. This key word was the visual encoding word (such as *sense, notice, distinguish*, etc.) that was embedded into the instructions for a visual task. In the English language, there are many words available to describe visual processes. Using multidimensional scaling, Dickinson and Szeligo (2008) determined that despite the overlap in the meaning of these words, participants consistently differentiate them from one another along one continuum of meaning. Because of this consistent differentiation, these words can be used as cues to direct the encoding process, without explicitly training participants on specific encoding strategies.

In the original experiment by Dickinson and Szeligo (2008), a within-subjects design revealed that participants respond faster to visual stimuli when they are asked to 'see' them (M=325ms) than when they are asked to 'perceive' them (M=369ms). In further experiments (Dickinson, Cirelli & Szeligo, 2013), these response time differences were not found to be associated with the frequency, familiarity, or word length of the visual encoding word used in the instruction. These findings support the hypothesis that what differs across instructional conditions is endogenous to the cognitive visual processes elicited when these visual actions are performed, and not merely word characteristics exogenous to the cognitive processes that affects response time, such as the retrieval of the meaning of the visual instruction verb itself. Prior to the current study, however, the way in which these instructional manipulations might affect recognition and false recognition rates in a within-subjects experiment had not yet been explored.

Theoretical accounts of false memory induction

As mentioned above, there have been a variety of experiments looking at how false memory can be manipulated by changing cues specific to the words being encoded (exogenous cues) and cues specific to the cognitive processes explicitly used during encoding (endogenous cues). Hunt and Einstein (1981) discuss the trade-off during encoding between item-specific information and relational information. For example, imagine you are given a list of words and asked to memorize them. Item-specific information refers to the features that distinguish one word from all the other words that must be encoded. For example, if all the words in a list were written in the color red, then remembering that the word *bed* was written in blue would be 'item-specific'. On the other hand, relational information refers to the features that are consistent between words that must be encoded. For example, if you see the words *bed*, *rest*, and *awake*, then remembering that all the words were related to the critical word *sleep* would be relational information. When relational information is encoded, the likelihood of false memory induction for critical lure words in a DRM paradigm increases (Hunt & Einstein, 1981; McCabe et al., 2004).

Arndt and Reder (2003) investigated how attentional focus on item-specific or relational information can be influenced by manipulating exogenous cues for encoding. When these authors presented participants with DRM word lists that were written in unique fonts, they found that false recognition of the critical lure word was lowest when each word during the encoding phase was presented in a unique font and highest when the words related to one semantic theme shared a font style. The authors argued that when each word was associated with a unique font, the font became a distinctive cue. This cue focused the participants' attentional resources towards item-specific information during encoding, and therefore away from relational information according to the trade-off discussed by Hunt and Einstein (1981). According to

Arndt and Reder (2003) such processing would reduce the likelihood of false memory induction. On the other hand, when a set of related words shared a font style, this cue became no longer distinctive. This then focused participants' attentional resources towards relational information during word encoding, which is thought to increase the likelihood of false memory induction (Arndt & Reder, 2003).

These results support the *impoverished relational processing* account of false memory induction (Arndt & Reder, 2003; Hege & Dodson, 2004; Hunt & McDaniel, 1993). This model suggests that during word encoding, attentional resources can be allocated towards a balance of relational information or item-specific information. When more distinctive item-specific information is encoded (and therefore the encoding of relational information becomes 'impoverished'), the likelihood of false memory induction is reduced. The *impoverished relational processing account* of false memory induction is congruent with other models suggesting false memory is affected at the level of encoding. For example, the source of activation confusion (SAC) model (Diana, Reder, Arndt & Park, 2006; Park, Arndt, & Reder, 2006) suggests that during encoding, activation can occur in both the content nodes, containing relational information about studied items, or episode nodes, containing item-specific information about studied items. The activation-monitoring model of false memory induction (Roediger, Balota, & Watson, 2001; Roediger, Watson, McDermott, & Gallo, 2001) also describes how during encoding, activation of critical lure words occurs because of the spreading of semantic activation during list word encoding.

Such encoding accounts contrast with the *distinctiveness heuristic* account of false memory induction (Dodson & Schacter, 2001; Dodson & Schacter, 2002; Schacter, Israel, & Racine, 1999). This alternative account has been used to describe how decision-making processes (as opposed to true encoding differences) can impact false memory induction rates at the time of recognition. It is argued that if participants expect to remember a certain type of cue during a recognition task, the absence of this cue will be sufficient to reject this word as having been previously presented (Dodson & Schacter, 2001). However, when cues used during encoding are later used to guide decision-making, differences are only found when between-subject and not within-subject designs are used (Schacter et al, 1999). In this sense, if researchers can use cues during encoding to affect false memory induction rates using a within-subject manipulation, as we have done in the present study, then differences found during recognition are likely due to encoding differences and not decision-making differences.

Present Study

The goal of the present study was to determine if and how implicitly manipulating endogenous cues for word processing affects false memory recognition in a DRM paradigm. By using a within-subjects design, findings will specifically address differences in *how* words are encoded, and will not address decision-making differences during recognition. Four of Dickinson and Szeligo's (2008) visual encoding words (*sense*, *notice*, *distinguish*, and *discern*) were embedded into the instructions for a word response task, during which words from 20 DRM lists (Stadler et al., 1999) were presented consecutively. Participant response times to the words in the word response task were recorded. This task was followed by an unexpected recognition task, which contained not only words that had been presented in the first task *and* distractor words, but also words from these DRM lists (including the critical lure words) that had not been presented in the first task. The four visual encoding words were assigned to specific DRM lists (counterbalanced across participants) so that responses to words from a specific list during the response task and the recognition task could be attributed to one of the four visual instruction conditions.

We hypothesized that, since these visual encoding words have been shown to influence how subsequent stimuli are processed, we can use response time to predict differences in relational versus item-specific encoding. For example, relational processing is considered to take less time and effort than item-specific processing (Butler, McDaniel, McCabe, & Dornburg, 2010; Hunt & McDaniel, 1993). Therefore, instructional conditions that encourage faster processing and encoding might encourage relational information processing, and lead to higher indices of false memory induction. Being asked to ‘sense’ or ‘notice’ visual stimuli has been found to elicit shorter response times in a subsequent visual task than being asked to perform visual actions such as ‘distinguish’ or ‘discern’ (Dickinson & Szeligo, 2008). It was therefore hypothesized that there would be a higher rate of false memory induction for words from lists that had been ‘sensed’ or ‘noticed’ versus words from lists that had been ‘distinguished’ or ‘discerned’. Essentially, instructional conditions that lead to faster word encoding during the response task were expected to lead to higher indices of false memory induction.

Method

Participants

Fifty-six undergraduate students (forty-seven females and nine males) from Laurentian University participated in this study and received course credit for their time. Ages of the students ranged from 17-26 years, with a mean age of 19.6 years.

Apparatus

The experimental program was written on Borland Delphi Professional Version 5 (Build 5.62) and run on Windows XP. This program (described in detail below) contained a word response task followed by a recognition memory task. The word stimuli in each part of the program were presented one at a time in black lowercase 80-character font on a white background. Participants responded to words in a response task by clicking the left mouse key. They also used this mouse key to click the buttons labelled either “old word” or “new word” during a surprise recognition task. The experiment took roughly 35 minutes to complete.

Materials

The visual encoding verbs ‘sense’, ‘notice’, ‘distinguish’ and ‘discern’ were embedded into the trial instructions “Press the mouse key immediately after you _______ that there is a word”. This created four instructional conditions. Each instruction was assigned to 5 of the 20 DRM word lists used (see appendix A for the word lists used). The order of the pairings was counterbalanced across participants to ensure that each of the four instructions was paired with each of the twenty lists an equal number of times. As a result, a false memory induction score for each instructional condition could be calculated. For example, consider a participant who had been asked to ‘sense’ the words from the DRM list related to the critical lure word ‘sleep’. If this participant later falsely recognized the word ‘sleep’, which was not presented in the original word response task, this would represent an example of false memory induction to words from lists that had been ‘sensed’. This is similar to the way in which false memory induction scores can be calculated for words related to words that had been previously presented in a certain font (an exogenous cue), which was done by Arndt and Reder (2003).

Procedure

The design was fully within-subjects. Participants, who were tested in groups consisting of one to three individuals, completed the word response task and then a recognition task that they had not been informed would occur beforehand.

Word response task. During the word response task, twelve of the fourteen words used from each DRM word list were presented one at a time in order. This resulted in 240 response trials in total, during which presentation of words was blocked in such a way that each word list was presented in full before the next list began. The order in which the lists appeared was held constant across participants (only the DRM list/instructional condition pairing was counterbalanced based on random assignment). This ensured that only the instructional manipulation and not changes in list order would be responsible for any observed effects across subjects.

In each of the 240 word response trials, the instruction containing one of the four visual action words would appear for 2000 ms, followed by a blank screen presented for an average of 500 ms (ranging from 250 to 750). The varying presentation rate of the blank screen was implemented to prevent anticipatory responding. This blank screen was followed by the presentation of the trial target word, to which participants responded with a click of the mouse. The latency of this response was measured by the computer as time of stimulus onset to time of mouse click. The words remained displayed on the screen until a total of 3000 ms had elapsed since word onset. It was necessary to hold presentation rate constant in order to control for exposure time. Between each of the 240 trials, a blank screen was presented for 500 ms. An example of a typical response task trial can be found in Figure 1. From this task, average response time for DRM words from each of the four instructional conditions was calculated.

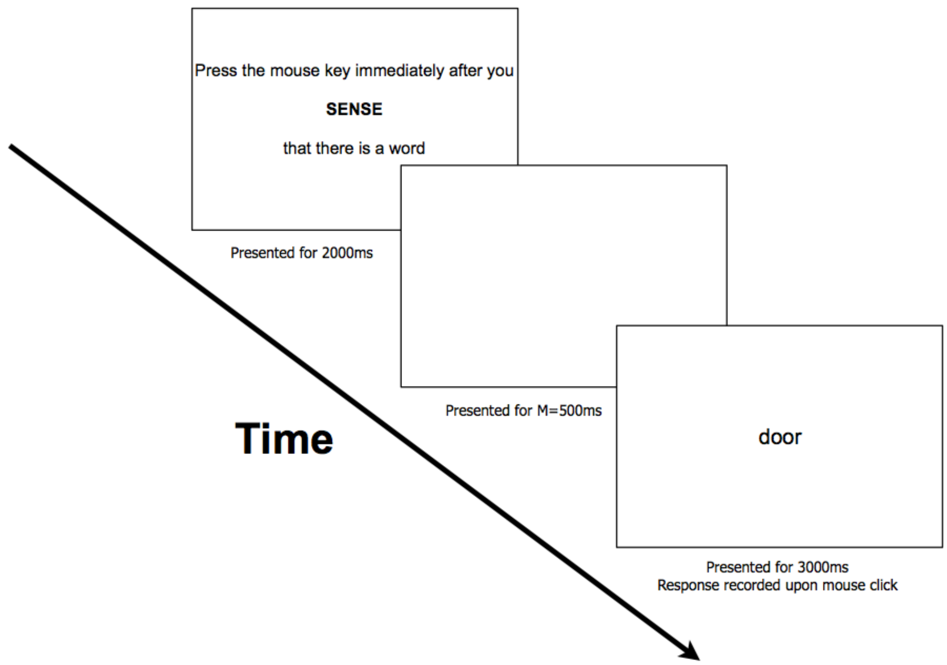

Figure 1: A typical trial in the word response task.

Recognition task. After the response task was complete, participants were given the following instruction for the recognition task (which the participant had not been warned about beforehand): <In the following task, when each word is presented use the mouse to click “old word” if the word WAS presented in the previous word response task, or click “new word” if it was NOT. Respond as quickly and accurately as possible. When you are ready, click the button below to proceed>. This signified the beginning of the recognition task. There were 120 trials in this task. The words were presented randomly, one word per trial. During each trial, two buttons were presented below the word; one read ‘old word’ and the other read ‘new word’. Upon clicking one of these two buttons the word disappeared, a blank screen (500 ms) was displayed, and the next recognition word appeared. The words used in this task were as follows: (1) One previously presented and two previously unpresented words from each of the DRM lists used in the response task (60 in total), and (2) 60 distractor words not related to any of the lists. From participant performance on this task, three dependent variables were calculated: response time to the words during the response task, hits (correct recognition of previously presented words), and false memory induction (incorrect recognition of previously unpresented words from the DRM lists).

Results

All analyses were tested using an alpha of .05. In some instances Mauchly's test indicated that the assumption of sphericity had been violated. Therefore, Greenhouse-Geisser corrections are reported where necessary. See Table 1 for a summary of the results.

Response Time

To determine if response time to words during the word response task differed by instructional condition, a repeated measures ANOVA was used. Results revealed that there was a significant effect of instructional condition on response time, $F_{(3, 165)}=9.30$, $p<.05$, $\eta^2=.15$. A post-hoc contrast analysis using a Bonferroni correction showed that words that participants had been asked to either 'sense' or 'notice' were responded to significantly faster than words they had been asked to 'distinguish' or 'discern', replicating previous findings (Dickinson & Szeligo, 2008) and validating our use of these words as an implicitly endogenous cue for encoding. There was no such instructional effect on response time found for DRM list words (previously presented or previously unpresented) during the recognition task, $F_{(3,165)}=0.85$, $p>.05$.

Hits

To determine the effect of processing instruction on correct recognition of previously presented words, a repeated measures ANOVA on the proportion of hits per instructional condition was used. There were no significant effects of instructional condition on hits, $F_{(3,165)}$=1.89, p>.05.

False Memory Induction

False memory induction was calculated by combining false alarms during the recognition task to the two DRM list words that had not been presented in the word response tasks; the critical lure word (commonly used in false memory analyses) and the thirteenth word on each of the lists. Again, since five of the 20 DRM lists were assigned to each of the four instructional conditions, an overall false alarm rate per instructional condition could be calculated. A repeated measures ANOVA was then used to determine if false alarm rates differed as a function of the instructional condition. A significant effect of instruction type on false alarm rate was found, $F_{(3,165)}$=3.42, p<.05, η^2=.06. A post-hoc contrast analysis using a Bonferroni correction (experimentwise alpha < 0.5) showed that the proportion of false alarms were higher for words from DRM lists that participants had been instructed to 'sense' or 'notice' compared to those from DRM lists that participants had been instructed to 'distinguish'.

Table 1
Means and Standard Deviations (SD) per instructional condition for Response Time (RT), Hits, and False alarms to related but previously un-presented words (F.A.).

Instructional Condition	RT (ms) M	RT (ms) SD	Hits (%) M	Hits (%) SD	F.A. (%) M	F.A. (%) SD
Sense	451[1,2]	160	61	25	41[1]	23
Notice	446[3,4]	169	54	31	40[2]	25
Distinguish	486[1,3]	192	53	27	33[1,2]	20
Discern	508[2,4]	213	54	26	37	22

Note. Instruction conditions with matching superscripts were found to be significantly different (p<.05) in post hoc comparisons.

Discussion

The current study investigated how implicitly manipulating encoding cues endogenous to the process of encoding itself can influence false memory induction. It was hypothesized that by using cues that encourage faster encoding, participants will process more relational information than item-specific information, and therefore false memory induction will be more likely. Replicating the finding that these visual action verbs can influence the speed of encoding (Dickinson & Szeligo, 2008), participants responded faster to word lists they had been asked to ‘sense’ or ‘notice’ verses word lists they had been asked to ‘distinguish’ or ‘discern’. In line with the hypotheses, false memory induction was more prevalent for lists participants had been asked to ‘sense’ or notice’ than lists they had been asked to ‘distinguish’. These results support the assumption that these visual action words are commonly understood across participants, and affect perceptual processing in a reliable way.

In conclusion, faster encoding led to greater indices of false memory induction. Because these findings were the result of a within-subject manipulation as opposed to a between-subject manipulation, they represent encoding differences as opposed to decision-making differences. Therefore, the results of the present study provide evidence supporting the encoding-focused accounts such as the *impoverished relational processing account* of false memory induction by suggesting that implicitly endogenous cues can be used to direct attentional resources to either relational or item-specific information during encoding. This complements previous results suggesting that either stimulus driven (exogenous) or overtly instructionally driven (explicitly endogenous) cues can predictably influence the rate of false memory induction.

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Appendix A

List #	Response Task Words	Recognition Task	
		Old	New (c.l., #13)
1	Door, glass, pane, shade, ledge, sill, house, open, curtain, frame, view, breeze	Door	Window, shutter
2	elastic, bounce, gloves, tire, ball, eraser, springy, foam, galoshes, soles, latex, glue	Elastic	Rubber, stretch
3	nose, breathe, sniff, aroma, hear, see, nostril, whiff, scent, reek, stench, fragrance	Nose	Smell, rose
4	thread, pin, eye, sewing, sharp, point, prick, thimble, haystack, thorn, hurt, injection	Thread	Needle, cloth
5	hot, snow, warm, winter, ice, wet, frigid, chilly, heat, weather, freeze, air	Hot	Cold, frost
6	note, sound, piano, sing, radio, band, melody, horn, concert, instrument, symphony, jazz	Note	Music, rhythm,
7	smooth, bumpy, road, tough, sandpaper, jagged, ready, coarse, uneven, riders, rugged, sand	Smooth	Rough, gravel
8	fast, lethargic, stop, listless, snail, cautious, delay, traffic, turtle, hesitant, speed, quick	Fast	Slow, wait
9	mug, saucer, tea, measuring, coaster, lid, handle, coffee, straw, goblet, soup, stein	Mug	Cup, sip
10	hill, valley, climb, summit, top, molehill, peak, plain, glacier, goat, bike, climber	Hill	Mountain, steep
11	hard, light, pillow, plush, loud, cotton, fur, touch, fluffy, feather, furry, downy	Hard	Soft, tender
12	steal, robber, crook, burglar, money, cop, bad, rob, jail, gun, villain, crime	Steal	Thief, criminal
13	bed, rest, awake, tired, dream, wake, snooze, blanket, doze, slumber, snore, nap	Bed	Sleep, drowsy
14	nurse, sick, lawyer, medicine, health, hospital, dentist, physician, ill, patient, office, stethoscope	Nurse	Doctor, clinic
15	mad, fear, hate, rage, temper, fury, ire, wrath, happy, fight, hatred, mean	Mad	Anger, enrage
16	low, clouds, up, tall, tower, jump, above, building, noon, cliff, sky, over	low	high, dive
17	sour, candy, sugar, bitter, good, taste, tooth, nice, honey, soda, chocolate, heart	sour	sweet, pie
18	cigarette, puff, blaze, billows, pollution, ashes, cigar, chimney, fire, tobacco, stink, pipe	cigarette	smoke, flames
19	garbage, waste, can, refuse, sewage, bag, junk, rubbish, sweep, scraps, pile, dump	garbage	trash, litter
20	table, sit, legs, seat, couch, desk, recliner, sofa, wood, cushion, swivel, stool	Table	Chair, bench

Distractor words in recognition task unrelated to lists: black, colour, blue, ink, bread, food, slice, toast, car, train, drive, race, city, streets, country, urban, flag, symbol, stripes, wave, foot, yard, ankle, inch, fruit, basket, juice, bowl, hair, dance, date, sister, king, crown, throne, chess, lion, circus, jungle, cage, mouse, strong,

beard, person, pencil, write, crayon, letter, river, boat, fish, bridge, shirt, pants, button, iron, spider, fright, crawl, ugly