



Research Article

Does Learning Styles Influence False Memory Generation?

Pallavi Ojha^a, Kedarmal Verma^b, Naveen Kashyap^{*c}

[a] Department of Humanities and Social Sciences, Indian Institute of Technology, Guwahati, India.

[b] School of Liberal Arts and Sciences, Mody University of Science and Technology, Laskhmangarh, Sikar, Rajasthan India.

[c] Department of Humanities and Social Sciences, Indian Institute of Technology, Guwahati, India.

Abstract

Human memory has been studied for several years. But due to its complex nature, the quest to understand properties/processes associated with it never fades. It has many properties, and one of them is its reconstructive nature. The vulnerability of false memories is not only dependent on exogenous factors (for example deep processing, retention intervals, list items, characteristics). Instead, it is also reliant on endogenous factors (for example age, emotions, mood state, arousal level), as well as with some personality factors. This study explores the idea that personality learning styles viz. field-independent and field-dependent influence the formation of false memory on the Deese–Roediger–McDermott (DRM) paradigm. The study reports that on recall test, field-dependent learners identify more critical lures as compared to field-independent learners. In the recognition test, the sensitivity of critical lures was found to be more in field-dependent individuals than field-independent. The response biases were conservative in critical lure recognition.

Keywords: false; memory; DRM; field; dependent; independent; GEFT, personality.



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Psychological Thought, 2021, Vol. 14(2), 363-377, <https://doi.org/10.37708/psyct.v14i2.579>

Received: 2021-01-13. Accepted: 2021-06-19. Published (VoR): 2021-10-31.

Handling Editor: Irina Roncaglia, Chartered Practitioner Sport & Exercise Psychologist, The National Autistic Society (NAS), United Kingdom.

*Corresponding author at: Indian Institute of Technology Guwahati, India. E-mail: nkashyap@iitg.ac.in



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Memory is not permanent; instead, it is very susceptible to changes (Brainerd & Reyna, 1996; Brainerd & Reyna, 2005; Loftus, 1975; Loftus & Pickrell, 1995; McDermott & Watson, 2001; Roediger et al., 2001; Roediger & McDermott, 1995; Vermaa & Kashyap, 2020.) False memory is one of the supporting evidence for the verification of the reconstructive nature of memory. In the last two decades, a large body of research has been done in the field of the false memory. Many factors affect the formation of false memory, and one of them is learning styles. It was observed that different cognitive styles *viz.* field-dependent, field-independent are processing false memory in different ways (Corson et al., 2009). Some are immune to it while some are prone to misinformation but still it is not very clear how can different learning styles impact the false memory formation. One of the main aims of this study is to investigate which cognitive style (field-dependent, or field-independent) and which retrieval strategy (recall, or recognition) is better in the formation of false memory. Deese–Roediger–McDermott (DRM) paradigm is a validated and reliable task for false memory formation in the laboratory set-up (Roediger & McDermott, 1995). It is a semantic task involving the presentation of semantically associated words list during encoding, and during retrieval where participants must recall or recognize the learned word list items. Retrieval phase is the time during which individuals make the recall or recognition error in terms of identifying the critical lure as list word. Critical lure words are false memory identifiers which are not present at the time of learning but are highly associated with



all their particular list items with highest backward associative strength (BAS) value (Roediger et al., 2001).

Two theories are prominently used to explain the formation of false memory *viz.* fuzzy-trace theory, and activation-monitoring theory. Fuzzy-trace theory supports the idea that information is stored in two traces. *i.e.*, verbatim trace, and gist trace. True memories are the results of the verbatim traces where detailed past information is recollected. In contrast, the false memories are the results of the gist traces of information in which semantic features of the previous information is processed (Reyna & Brainerd, 1995). Activation-monitoring theory is also prevalently used as an approach for the explanation of false memory formation. It explains that false memory formation is the result of the process active at both encoding (consciously or unconsciously activation of related lures) as well as retrieval of information. These processes result in source monitoring error where participants have difficulty in discriminating words presented during encoding and lures at retrieval (Johnson & Raye, 1981). Besides these false memory generation theories, the encoding phase conditions can also prompt participants' attention for item-specific processing, which might be context, or background. This study evaluates the role of individual differences and cognitive learning style (which are related to the item-processing strategies) in false memory generation.

Field dependent and field-independent learners are two different cognitive styles based on the different type of information processing approach. Field independent learners process the information analytically and tend to perceive items specifically in an embedded context. They use the item-specific processing approach to distinguish the parts of the whole. Field dependent learners perceive all the parts globally in an embedded context. They use relational processing approach to encode the information and cannot easily differentiate parts of the whole (Witkin et al., 1977). Encoding conditions that prompt distinctive processing help focuses the participant's attention on individual item information that is to the processing of differences relating to a context or a background (Corson, et al., 2009). Consequently, false memory should be higher when people do not process item-specific information and would be less, as higher item distinctive information will be processed. The Group Embedded Figure Test (GEFT: Oltman et al., 1971) is the most favorable test to discriminate the cognitive style learners (Field-dependence-independence, FDI). GEFT task is administered to separate the individuals into their constituent learning style. In this task, participants have to identify/locate simple figures which are embedded in the complex figures. For this, they have to outline that simple figure



precisely, accurately and within the limited time given to them. The performance on this GEFT task categorizes them based on global or analytical strategy. Global strategists are not able to distinguish simple figures from complex figures in GEFT. In real-life situations, these individuals analyze the situation as a whole and use a holistic approach. On the other side, analytical strategists are better in separating the simple components from complex one in GEFT task. These individuals can process information locally. The field-independent individuals have less difficulty in isolation of relevant information from the background context, whereas field-dependent learners face difficulty in distinguishing simple information from complex one. (Emmett et al., 2003).

In the present study, it can be suggested that field-independent individuals will quickly separate the words in the list from their context which activates and supports the ability to distinguish and thus leads to fewer false recall and false recognition than field-dependent individuals. However, Spiro and Tirre (1980) in their experiment have found that field-independent individuals are using more global processing than field-dependent individuals in handling the situations. Field-independent individuals use more context-based processing of memory (in case of positive mood) that can enhance false memories on Deese–Roediger–McDermott (DRM) tasks (Corson, 2002, 2006). Field-independency/dependency of volunteers thus might serve as one of the factors that may impact the formation of false memories. However, still, it needs more research as a definite cause is unclear.

In this study, the recognition memory is measured using signal detection theory, where sensitivity and response biases were calculated for critical lures and true target items. Recall memory is calculated by measuring mean scores of critical lures, intrusions, and true target items.

Methods

Participants

Eighty healthy graduating students (50 males and 30 females) ($M_{\text{age}} = 19.27$; $SD_{\text{age}} = 1.27$) of Indian Institute of Technology Guwahati were recruited. All participants were compensated for experimentation by giving bonus grade points in a psychology course. All participants were normal with average memory. Informed consent was obtained from all individual participants included in the study.



Materials

Semantic Associate Task: The Deese–Roediger–McDermott (DRM) task was used to induce false memories for words. DRM paradigm used semantically associated word lists. Two groups (field-independent and field-dependent) of subjects participated in the experiment. All Subjects performed recall as well as the recognition test. The volunteers were assigned to the assigned groups after getting the score of the GEFT test. Total ten lists with ten words in each list were used which were semantically associated and were extracted from previously developed false memory word corpus (Stadler et al., 1999; Roediger & McDermott, 1995; Roediger et al., 2001; Deese, 1959). Words were presented using e-prime presentation software on the centre of the computer screen with each word written in font size of 14 Time New Roman fonts. Words on each list were arranged in descending order of backward association strength (BAS). The within lists factors, i.e., word length and, backward association strength value, were made constant across all lists.

GEFT Task: Group Embedded Figure Test (GEFT) is the psychological assessment tool for the identification of field-independence and field-dependence (Witkin et al., 1971). This test consists of a total of 18 complex geometrical figures which have simple figures within them. Participants have to identify the simple figures in the complex figure. For this identification, they have to draw a line over the simple figure with a pencil (in off-line mode) and dragging and clicking with a mouse (in online mode). *GEFT* is a time-based test in which first is a practice section consisting of 7 problems with a 2-minute time limit while the second and third sections include of 9 problems and a 5-minute time limit for each. The primary measure is the number correct out of 18.

Procedure

The whole procedure of this study is divided into two phases (see figure 01). In the first phase, the GEFT test was administered and analyzed to get field-independent and field-dependent individuals. In the second phase, the DRM task was run on both field-independent and field-dependent groups separately and analyzed for final results of false memory formation.

Phase I: In this phase, the GEFT test was employed to separate the field-independent and field-dependent individuals. A median split of the score was obtained. Participants scoring above-



median are grouped as field-independent while those scoring below-median are grouped as field-dependent.

Phase II: This phase is followed by phase I, which includes the administration of the DRM task on both FI and FD groups. Each group is randomly examined for false memory induction in the morning time between 10:00 AM to 12:00 PM. This DRM task consists of two sessions, *viz.* one session for encoding, and the second session includes the retrieval/test phase. During the *encoding session*, each participant has learned all the list items through the visual presentation with E-prime presentation software ([Psychology Software Tools, n.d.](#)), where each list item was presented for 3000 milliseconds with an inter-stimulus interval of 2000 milliseconds. All the list items were displayed sequentially in the centre of the computer screen in a black-white font. During the *retrieval session*, both recall and recognition test were performed simultaneously with the intervention of a distractor task to prevent the interference of one test over another, where a recognition test followed the recall test. Both retrieval tests were employed immediately after the encoding session with a distraction task between them. In the *recall test*, participants were instructed to recall the name of all the words in any order. All the responses were taken on plain white paper. In the *recognition test*, participants had to recognize learned list items from the recognition list by “old/new” judgment strategy. Each recognition list consists of 3 old words (from learning list), one critical lure word (highly related with their list items), and three distractor words (unrelated to list items), so total 70 words would be identified. During “old/new” judgment, participants have to give their response by pressing assigned keyboard keys (o = for old words, and n = for new words). The next word would appear after the subject’s successful recording of their desired response.



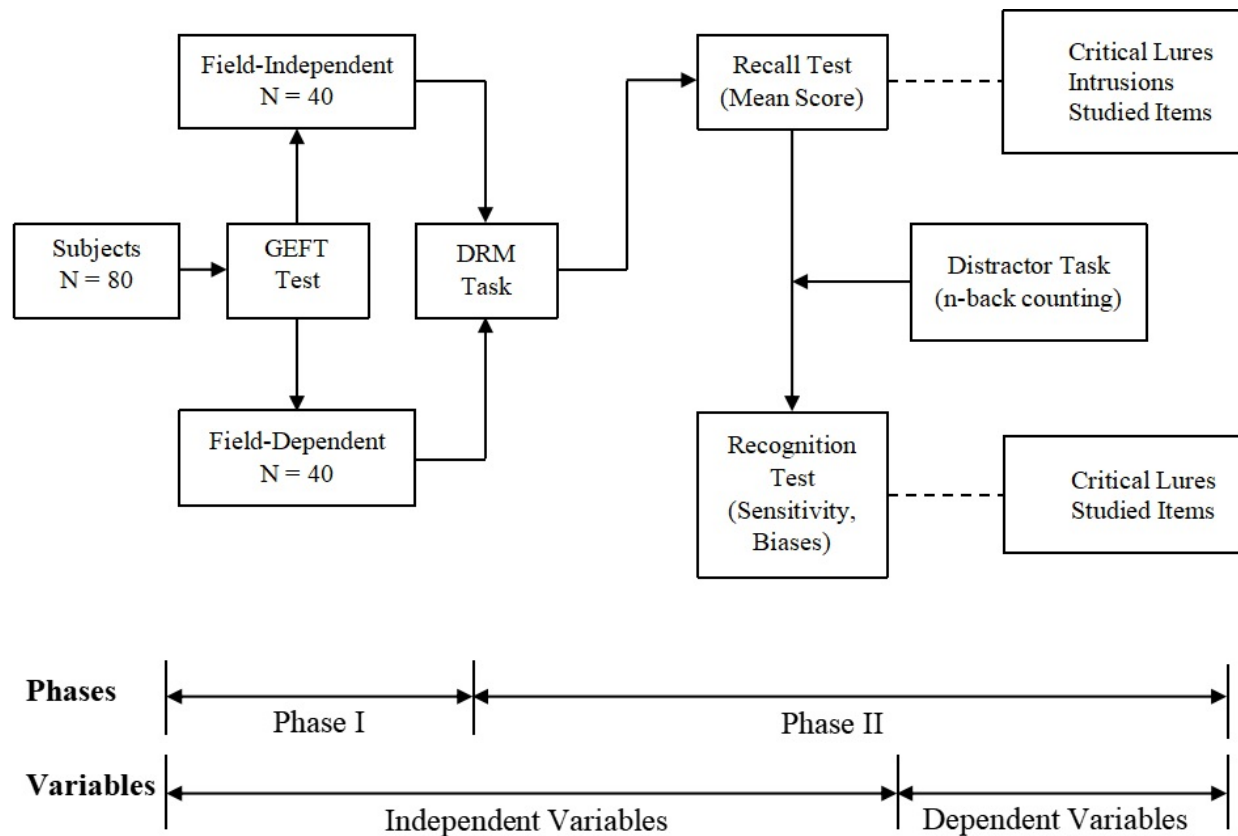


Figure 1. Study design explaining study protocol and IV and DV.

Memory Measurement

In the recall test, the mean recalled scores of critical lures, intrusions, and studied items were measured whereas, in the recognition test, memory scores were calculated in terms of their sensitivity and response bias (Pardilla-Delgado & Payne, 2017). During raw memory measures, the true targets rates were defined as the hit rate [H], which is calculated as; “old” response given to previously learned items divided by the total number of presented study items. The false rate is defined as false alarm rate to critical lures [FAC], which is calculated as; “old” response given to related lure divided by the total number of the related lure which was presented. The foil rate is defined as false alarm rate to foils [FAF], which is calculated as; “old” response given to unrelated foils divided by the total number of unrelated foils presented. Using non-parametric signal detection, discriminability was calculated as A' [hit rate (H) and foil rate (FAF) for true recognition, and false rate (FAC) and foil rate (FAF) for false recognition] with their response bias B' (Donaldson, 1992; Snodgrass & Corwin, 1988).

The calculating formula for true recognition is $A' = \frac{1}{2} + [(H-FAF) (1+H-FAF) / [4H(1-FAF)]]$, when $H \geq FAF$ and $A' = \frac{1}{2} + [(FAF-H) (1+FAF-H)] / [4FAF(1-H)]$ when $FAF \geq H$.

The calculating formulas for false recognition are $A' = \frac{1}{2} + [(FAC-FAF) (1+FAC-FAF)] / [4FAC(1-FAF)]$ when $FAC \geq FAF$ and $A' = \frac{1}{2} + [(FAF-FAC) (1+FAF-FAC)] / [4FAF(1-FAC)]$ when $FAF \geq FAC$.

The calculating formulas for response bias for true targets are $B'' = [H(1-H) - FAF(1-FAF)] / [H(1-H) + FAF(1-FAF)]$ when $H \geq FAF$ and $B'' = [FAF(1-FAF) - H(1-H)] / [FAF(1-FAF) + H(1-H)]$ when $FAF > H$.

The calculation formulas for response bias to false items are $B'' = [FAC(1-FAC) - (FAF(1-FAF))] / [FAC(1-FAC) + FAF(1-FAF)]$ when $FAC \geq FAF$ and $B'' = [FAF(1-FAF) - FAC(1-FAC)] / [FAF(1-FAF) + FAC(1-FAC)]$ when $FAF > FAC$.

The A' values vary between the range from 0.00 to 1.00, where the higher score of A' 's indicates the greater sensitivity and low score indicates lower sensitivity. The response bias varies from -1.00 to $+1.00$, where the negative value of response bias indicates the liberal bias, a positive value of response bias shows the conservative bias. If the value of response bias is equal to zero, then it means the neutral bias.

Statistical Analysis

IBM SPSS (Statistical Package for Social Sciences) statistics 20 software was used to analyze the data. For the GEFT test, the median value of the obtained data was calculated and used to distinguish cognitive style learners. The quantification of false memory was calculated by analyzing critical lures, intrusions, and studied items. In the recall test, the mean proportion score was calculated, and in the recognition test, the sensitivity and their response biases were calculated. The hypothesis was tested by applying the independent t-test between the FI and FD groups.



Results

GEFT Test:

Scores obtained on GEFT test were median split. Participants scoring above the median were classified as field-independent and below the median as field dependent. The median score was 11.76 (see Table 01).

Table 1.
GEFT Test Score

		GEFT Score	Median Score
GEFT Test	Field-Independent	15	11.76
	Field-Dependent	11	11.76

Recall Test:

There was a significant difference in the scores of critical lures for field-dependence ($M = 4.00$, $SD = 0.57$) and field-independence ($M = 1.00$, $SD = 0.40$) conditions; [$t(78) = 4.24$, $p < .05$]. (See Table 02). There was no significant difference in the scores of intrusions for field-dependence ($M = 2.75$, $SD = 1.70$) and field-independence ($M = 2.75$, $SD = 1.70$) conditions; [$t(78) = 0.00$, $p > .05$]. (See Table 02). There was a significant difference in the scores of studied items for field-dependence ($M = 44.5$, $SD = 14.20$) and field-independence ($M = 19.75$, $SD = 7.04$) condition; [$t(78) = 3.12$, $p < .05$]. (See Table 02).

Table 2.
Mean Proportion Scores of Recall Test [Mean \pm SD]

Dependent Measures Cognitive Style	Critical Lures *	Intrusions ^{NS}	Studied Items *
Field-Independent	1.00 \pm 0.40	2.75 \pm 1.70	19.75 \pm 7.04
Field-Dependent	4.00 \pm 0.57	2.75 \pm 1.70	44.50 \pm 14.20

* $p < .05$, and NS $p > .05$

Recognition Test:

There was a significant difference in the scores of critical lures for field-dependence ($M = 0.86$, $SD = 0.03$) and field-independence ($M = 0.78$, $SD = 0.06$) conditions; [$t(78) = 2.367$, $p < .05$].



(See Table 03). There was also no significant difference in the scores of studied items for field-dependence ($M = 0.91$, $SD = 0.07$) and field-independence ($M = 0.82$, $SD = 0.09$) condition; [$t(78) = 1.716$, $p > .05$]. (See Table 03). The response biases for critical lures for both FI and FD individuals was found conservative, whereas FI individuals showed liberal bias and FD individuals showed conservative bias for true target items (see Table 03).

Table 3.

Mean Scores of Sensitivity of Recognition Test [Mean \pm SD]

Dependent Measures	Cognitive Styles	Field-Independent	Field-Dependent
Sensitivity			
Critical Lures *		0.78 \pm 0.06	0.86 \pm 0.03
Studied Items ^{NS}		0.82 \pm 0.09	0.91 \pm 0.07
Response Bias			
Critical Lures ^{NS}		0.14 \pm 0.15	0.28 \pm 0.60
Studied Items ^{NS}		- 0.10 \pm 0.37	0.06 \pm 0.21

* $p < .05$, and ^{NS} $p > .05$

Discussion

The primary objective of this study was to understand the role of cognitive style on false memory formation on the DRM task. In this study, field-dependent (FD) learners recalled more critical lure words (false memory identifier). They studied words (true memory identifiers) than field independent (FI) learners, but the intrusions were equally recalled by both FD and FI learners. The false recognition (in terms of sensitivity) of critical lures words were more in FD individuals than FI individuals with both showing conservative bias. These findings are in-line with previous research (Corson et al., 2009), where they reported that field-dependent learners identified more critical lures in both recall and recognition tests. None of the previous studies investigating cognitive styles and false memories has reported sensitivity and response bias parameters to the best of our knowledge. The present study calculated false recognition in terms of sensitivity and response biases. A recent study reports (Trippas et al., 2015) that analytical cognitive style influences response bias by motivated reasoning. Response biases can be influenced by experimentation manipulations (Wilson, 2017) and we believe that similar response bias for both the groups in the present study could be a possible outcome of recognition test followed by recall. Further, research is needed to explain the relationship between cognitive style learners and response biases.



With these outcomes, it can be interpreted that, field-dependency and independency are not only dependent on the association of items, but rather field-independent learners are better in monitoring the information and can easily distinguish items than field-dependent learners. The ability to distinguish the learned items from newly encountered items might lead to fewer false memories, so in this sense, field-independent learners identify less critical lures than field-dependent learners. Concerning the distinctive processing of information, [Hunt and Einstein \(1981\)](#) explained two processes, i.e., item specific and relational approach. In the item-specific encoding process, participants draw their attention to the particular distinctive features of items for encoding, and this information processing strategy helps in discriminating the studied and unstudied items. In relational information processing, participants draw their attention to standard features and make relations with the concepts which are stored in memory. This relational approach during encoding helps inactivation of critical lures. In this study, we believe that field-independent learners are utilizing item-specific encoding processes, and easily monitoring/distinguishing studied and unstudied items.

In contrast, field-dependent learners are using a relational processing approach, which is leading to more recall of critical lures. In activation-monitoring approach, studied and unstudied items are monitored during retrieval, which leads to easy identification of items. This distinctive processing reduces the relational processing and therefore, reduction in false recalls or recognition ([Hege & Dodson, 2004](#)).

Interestingly, both processes, i.e., item-specific and relational approach, are concerned with the encoding stage. In contrast, misattribution/source-monitoring error generated for internally activated unstudied items and the studied items are related to the retrieval stage, which will together lead to false memories formation ([Tsakanikos, 2006](#)). Thereby usage of item specific (FI learners) and relational approach (FD learners) may be the leading cause of false memory formation in these personality styles. Additionally, several endogenous factors, including emotions, mood states, and arousal level, could have affected false memory. Further research should focus on understanding the underlying mechanism of false memory formation in people with different personality styles.



Limitations

The present study has some limitations that can be addressed in future studies. One main limitation of the present study is the use of high frequency critical lures alone. Future studies can use both high and low frequency critical lures. Another limitation that future studies can address is independent testing of recognition and recall sessions. In the present study both retrieval sessions followed simultaneously which could have led to carry over effects. Another interesting possibility for future studies could be to test relationship between cognitive styles and false memories induced using varied methodologies.

Conclusion

The study results suggest that the reconstruction of information is not only depending on the external factors known as endogenous factors. It can also be affected by the individual learning styles, and the unique personality styles of the learners. This study suggests that field-dependent learners identify more critical lures than field-independent learners in the recall test. In the recognition test, the sensitivity of critical lures was also found to have significant differences, where FD learners were to be found more sensitive than FI learners.

Ethical approval: All procedures performed in these studies involving human participants were in accordance with the ethical standards of the institutional (Indian Institute of Technology Guwahati) and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Funding/Financial Support

The authors have no funding to report

Other Support/Acknowledgement

The authors have no support to report.

Competing Interests

The authors have declared that no competing interests exist.

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About the Authors

Pallavi Ojha is a research scholar in psychology at Department of Humanities and Social Sciences, Indian Institute of Technology, Guwahati, India.

Kedarmal Verma is an assistant professor in psychology at the School of Liberal Arts and Sciences in Mody University of Science and Technology, Laskhmangarh, Sikar, Rajasthan, India. Author`s research interest is experimental psychology, and cognitive psychology.

Naveen Kashyap is an associate professor of psychology at Department of Humanities and Social Sciences, Indian Institute of Technology, Guwahati, India.

Corresponding Author's Contact Address^[TOP]

E-mail: nkashyap@iitg.ac.in

