Enhancement of Memory Through Curiosity-Driven Learning

Sarah Goldberg, Amanda Gibbs, Belen Martinez Caro-Aguado & Maribel Munoz
Department of Psychology
Lake Forest College
Lake Forest, Illinois 60045

Abstract

Purpose

The purpose of this literature review was to analyze the findings from various different studies in the last 55 years (1957-2012) in respect to curiosity as a motivational factor and its influence memory.

Conclusions

From the 10 research articles selected from PsycINFO, the findings suggested significant influences of curiosity on memory. The articles selected utilized a variety of subject demographics, methodologies, and other factors.

Implications

Curiosity is a motivational factor, which affects memory. By incorporating curiosity into ways of teaching and learning, the memory of students can be enhanced and therefore education can be improved.

Introduction

Curiosity is one of the major driving forces that compels people to learn and explore. The desire to relieve the anxiety of curiosity serves as an incentive, which is believed to cause people to search for answers. This can be beneficial but is also potentially dangerous in certain situations. According to Kang, Krajbich, McClure and Wang (2009), curiosity can also be beneficial as it is thought to enhance memory. According to Jepma, Verdonschot, van Steenbergen, Rombouts and Nieuwenhuis (2012), there are two different types of curiosity: perceptual and epistemic. In addition, there are two categories of each type of curiosity, specific and diversive. Perceptual curiosity is aroused by sensory factors that are novel, while epistemic curiosity is driven by the desire to learn and acquire information. Therefore, epistemic curiosity leads to intentional learning and perceptual curiosity leads an unintentional way of acquiring information. Furthermore, specific curiosity involves seeking information about a particular topic, and diversive curiosity involves the desire to learn about general information (Jepma et al., 2012).

To assess the question of whether or not curiosity enhances memory, we analyzed all of the articles that had a measure of curiosity regarding a particular topic as well as a measure of memory recall after the study. This topic is important to study because characterizing the factors that mediate memory can help in making the educational system better by engaging students more in their classes and therefore raising grades. This can help students if they are able to learn more while studying something they are curious about. The curiosity that is involved in intentional learning (epistemic curiosity) would be the major determinant in enhancing memory in the educational system. We also, however, wanted to see the effect of perceptual curiosity on memory. Thus, this literature review is not specific towards a certain type of curiosity, but rather covers the broader topic that is curiosity.

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Methods

A study conducted by Jepma et. al. (2012), in which curiosity was a mediating factor for memory enhancement, inspired the the topic of the influence of curiosity on memory. A systematic literature search was executed using a database that contains an extensive amount of academic journals including empirical articles, chapters of from textbooks, literature reviews, and peer-reviewed journals. This database is PsycINFO, where the key terms utilized to produce this systematic literature search were 'curiosity', 'memory', 'attention', 'visual retention', and 'learning', in different combinations. We postulate that the combinations of keywords into the phrase "curiosity AND memory" was most effective in generating results of relevant empirical studies. By inserting this phrase into PsycINFO, there was a result of 153 articles, from which approximately 5 articles were selected by reading the title and the abstracts to identify the relevance to the topic in question. Another way of searching for empirical articles was to look at the reference section of the articles found through the database, and to select articles relevant to curiosity and memory. Overall, the articles that were considered were in the English language, they included human subjects, with the exception of one article, focused on curiosity and memory, and had a variety of subject demographics. Articles were also chosen in regard to their methodology, as to ensure to obtain a varied range of methodologies, including fMRIs, sensing of brain stimulation through electrode implantation, recording of visual attention, and questionnaires. Articles that were ruled out were those that did not measure memory as a result of curiosity, or that were not empirical research studies. All articles chosen were then evaluated, and the data collected were analyzed and combined by all the authors of this literature review.

Results

A total of 10 articles were analyzed for this review based on their pertinence to the purpose of the review. The articles covered a 55 year span of research and the participants ranged from 5 - 40 years old, with the majority being undergraduate students. Many of the studies included samples that were large, except for the Butler study that only used five Rhesus monkeys (1957). While all of the studies had different measures of how curiosity affected memory, overall the articles were consistent with the finding that both types of curiosity enhance memory.

A number of studies under review looked at a variation of curiosity levels or levels of knowing and found that what one knows or desires to know impact memory. Bull and Dizney (1973) focused on the differences among retention scores between three groups (high-curiosity, low-curiosity, and exhortation-to-attention), which were all presented with different pre-questions intended to interest the participants in an essay. What they found was a significant difference between retaining relevant and incidental information for low curiosity pre-questions, $t(22) = 2.77$, $p < 0.05$, and high curiosity pre-questions, $t(23) = 2.88$, $p < 0.05$. No significant difference was found between incidental and relevant recollection among the exhortation to attend group, $t(22) = 0.77$, ns. A study by Connolly and Harris (1971) in which children looked at incongruous and congruous pictures, found that there were significant effects between each type of picture. Children looked at incongruous pictures much longer than congruous pictures, and also children's change of expression

lasted longer for incongruous pictures than congruous pictures. Therefore, there were different levels of curiosity, with incongruous pictures eliciting much higher levels compared to congruous pictures.

Kang et al. (2009) also inquired about memory retention as a result of level of curiosity and found that curiosity had a strong impact on the ability of a participant to recall answers to questions based on their ranked curiosity level. The accuracy rates were significantly different between high and middle curiosity items, $t(10) = 2.10$, $p < 0.05$, in which there was greater recall accuracy among high curiosity items than middle curiosity items. Further, middle curiosity items were recalled with greater accuracy than low curiosity items and the results were significantly different, $t(12)=2.37$, $p<0.05$. Thus, higher curiosity levels lead to better recollection. This finding also remained consistent in the study by Alberti and Witryol which had third and fifth grade students complete a laboratory task of varying curiosity (2001). Alberti and Witryol found that there was a positive correlation between curiosity and intellectual performance ($r = .35$, $p < .002$). Another interesting finding from this study was that intellectual performance was not only linked with student curiosity but also with the teacher ratings of curiosity ($\beta = .66$, $t = 3.99$, $p < .001$).

Two studies we reviewed focused on curiosity as a result of feelings of knowing. The first conducted by Litman, Hutchins, and Russon (2005) found correlations between epistemic curiosity and the various feeling-of-knowing states. Small positive correlations (M $r = .21$) were found between curiosity levels and the knowing states “don’t know” and “tip of the tongue.” For the “I know” state, curiosity showed a negative correlation ($r = -0.14$). This shows that for the unknowing feelings, the more intense states produced greater curiosity, however when one felt confident in their knowledge, they were increasingly less curious.

Boykin and Harackiewicz (1981) also found that performance decreases as uncertainty increases. They also found that high levels of uncertainty lead to greater curiosity which in turn is important for recognition and recall. They found that there is a significant interaction between the uncertainty group and problem uncertainty ($p < 0.05$), expressed as a positive, linear correlation. Subjects who were least certain in their answers were the ones who had the greatest curiosity with the correct answers. Conversely, those who felt certain in their answers were not as eager to uncover the answers.

Visual curiosity was of particular interest in two articles reviewed. Butler (1955) utilized rhesus monkeys as a model for human behavior to study how visual stimulus deprivation impacts visual curiosity of the subjects. Different conditions were specified by the length of the visual deprivation and the dependent variable was the frequency of visual responses. Differences between conditions were significant at the 0.05 confidence level; as the mean response frequencies increased, the duration of deprivation was lengthened. Kintz and Lippman (1976) furthered this idea by finding that free visual looking time is quite a specific function of curiosity itself and is aroused within the observer through the perception of a particular stimulus. Recognition, however, they found, is dependent on upon memory rather than any types of curiosity. Thus, curiosity is important in the formation of a memory but not in the recollection once a memory has already been formed.

There were a number of articles that analyzed the neural underpinnings of curiosity such as the article by Jempa et. al., which found that hippocampal activation mediates the enhancement of memory due to the relief of perceptual curiosity (2012). The study conducted by Kang et al. suggested that epistemic curiosity, unlike perceptual curiosity, increases memory through striatal activation because of increased attention and incentive to learn (2009).

Discussion

An article by Collins, Litman and Spielberger (2004) discussed the idea of curiosity as a personality trait. Curiosity is present in all humans, but at different levels. Due to the fact that curiosity is present at different levels, it is reasonable to conclude that higher levels of curiosity result in higher levels of learning. According to an article by Alberti and Witryol (1994), curiosity enhances cognitive development. Jepma et al. found that hippocampal activation is the reason for this finding (2012). The researchers hypothesized that relief of curiosity is rewarding and enhances learning; this process is mediated by a neural basis for curiosity. This concept is also discussed by Connolly et. al. (1971). We already know that there are neural pathways for curiosity, and these pathways can differ dependent upon the individual. The neural pathways in the brain impact curiosity, which impacts brain development. The relief of curiosity leads to hippocampal activation which enhances incidental memory.

Butler (1957) discusses another aspect of curiosity: visual exploration. If people are deprived of visual stimuli, they will experience a higher level of curiosity when they are exposed to it once more. Therefore, curiosity is something that is necessary to our functioning due to the fact that we crave it when we are deprived of it. Boykin and Harackiewicz’s (1981) research on this topic contributes to this discussion as well. He discovered that performance decreases when knowledge is lacking, and uncertainty levels are high. High uncertainty results in high curiosity. Boykin discovered that high uncertainty (and therefore high curiosity) causes better memory. This research is supported by Bull and Dizney (1973). She found that being asked unusual and interesting questions before exposure to material enabled participants to retain the material that followed the questions because the questions peak interest in the material, and therefore stimulate curiosity.

As for memory, Kintz and Lippman (1976) stressed the importance of acknowledging the difference between creating memories and recalling memories. Creating memories has to do with curiosity and exploration, whereas recalling memories is not closely related to curiosity. Litman (2005) disagrees, claiming that we are most curious when we feel the need to recall something that we are close to remembering. This is commonly known as “having something on the tip of the tongue.” On the contrary, we are least curious when we feel that we already know something. In addition, when we know nothing, we aren’t curious at all. We have nowhere to begin, and therefore no curiosity to drive us to acquire the knowledge.

The research done on curiosity and memory can be further extended by analyzing brain activity. Most articles did not look at brain activity but doing so may be a better indicator of curiosity than a survey which could suffer from demand characteristics. Some other further studies that would be helpful in filling the gap of knowledge as to how curiosity affects memory are studies that look at how students do in electives versus those that are required. Having required classes may actually be negative because the grades of students may be lowered and they would not end up remembering as much information from those classes either way.

In conclusion, curiosity is important because it is relevant to the educational system. Knowledge of how curiosity and memory interact can aid students in the classroom, leading to an increase in interest and higher levels of learning in schools. Therefore, the knowledge that we attain from these studies can

help us shape the curriculum of students in order to maximize their learning potential.

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