

Encoding Specificity & Retrieval in Typical Children

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Abstract

It had been found that 'Context' & 'State' in which the information had been encoded, if remains similar at the time of recall then retrieval can be more efficient as per 'Encoding Specificity' which can either be Context-Dependent or State Dependent. But similarity in 'Environmental cues' available isn't always the same & changes in context & state after the info had been imbibed causes how much of retrieval change, the following review portrays the same notion. What environmental cues can ameliorate retrieval in children & do encoding specificity stays effective in most contexts of retrieval, this review tried to answer such interrogations.

For some population like 35-months old children, the phenomena had been proven to be supportive but unfortunately futile for others. Factor like odour didn't have any effect on memory recall in spite similarity in olfactory stimulation at the time of encoding & recall. Hence, the review endeavoured to sketch out the role of encoding specificity along with its effectiveness and pros & cons.

Keywords: Encoding specificity, Context-dependent learning, State-dependent learning, Context Reinstatement, Retrieval, Recall etc.

Introduction

Encoding Specificity is the tendency for human memory of info to be better recalled if related info (such as surrounding or physiological state) that is available when the memory is 1st formed is also available when the memory is being retrieved. It was introduced by Thomson & Tulving who quoted that contextual info which is encoded with memories would impact the retrieval as well. They demonstrated it via the help of recognition-memory task where it was found that memory accessibility is aided by retrieval cues which depend on encoding pattern which in turn vary from instance to instance. For e.g., if we are watching a particular television show while eating peanuts, the next time we eat peanuts we might find ourselves thinking of the show that we watched. Basically, it is divided into 2 types i.e.,

- Context-Dependent Learning
- State-Dependent Learning

The former refers to physical surrounding of a person where the info had been encoded. For e.g., taking chemistry test in the same lab where the chemicals had been tested (Ciccarelli, 2019) but the later states that memories formed during a particular physiological/psychological state will be easier to recall in the same state at a later context (Eich & Metcalfe, 1989). Similarly, not only state & context but 'Context reinstatement' can lead one to incorporate thoughts from past into current mental state. The recall here is a type of memory retrieval in which info to be retrieved are 'pulled' out of the memory with few external cues available. In some on the research, memory reinstatement had proven to be beneficiary for efficient recall but not in all. As compared to being sober, state-dependent memory is found to be more effective when a person is intoxicated. It is strongest with free recall than retrieval cues. Even in case of Advertisements, when the nature of adds is 'Emotional' i.e., focusing on Episodic memory, it leads to much higher recall.

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In 2019 Sonne et al., conducted a study on 80 thirty-five-month-old children in 2 setting i.e., 1 group of children returned to the same room (N = 40) & the other group returned to a different room (N = 40) but similarly furnished after 1 week. Results indicated that children returning to a different room produced fewer spontaneous memories relatively to children returning to same room highlighting encoding specificity principle of Tulving & Thomson (1973). But interestingly, despite alteration in the room for later group, children produced spontaneous memories. There wasn't any significant difference between groups. It could be possibly due to childhood amnesia that why complete recall wasn't observed in the groups. Also, which cues in the context are effective for children's retrieval, wasn't discovered.

Hipskind performed a comparative study in 2020 between 4-years old (N = 20) & adults (N = 20) in order to investigate developmental differences in memory retrieval during new experiences. After learning, subjects were cued with a shape & tasked with retrieving the target object associate. Participants were cued with an identical shape from learning on half trials & on remaining trials, they were cued with a similar but non-identical shape. Both adults & children depicted retrieval when cued with similar yet non-identical shapes. For adults, retrieval was slow & less accurate for non-identical V/s identical cues, but children manifested no difference in retrieval as a function of cue similarity. This study highlights that mnemonic generalised in early childhood is a consequence of less detailed memory representation. It portrays how mnemonic specificity & generalisation interact across development. As the perceptual discrimination increased so did retrieval accuracy for both groups suggesting a relationship between encoding specificity & mnemonic retrieval success. It further suggested that prior knowledge & environmental constraints promote encoding specificity & retrieval.

In a study by Jawoslawska in 2016 with a sample of 112 children divided into 2 experimental conditions of ages 7-9, children recalled sequences of spoken action command under presentation & recall condition that either did or didn't involve their physical performance. Recall was enhanced by carrying out the instructions as they were initially presented & also by performing them at recall in both experiments. Unfortunately, the enactment merit at presentation didn't reflect a general benefit of dual exposure of presentation. Benefits of action-based recall were reduced following enactment during presentation highlighting that positive effects of action at encoding & recall could have common origin.

Larzabal et al., in 2018 performed a study on 44 participants to probe whether explicit memory is responsible for drawing that had been presented once or thrice, 2 secs each time on average, approx. 12 years earlier. In such a case, subjects were able to recognise pictures above chance level. Preserved memory was mainly observed in younger participants where stimulus was seen thrice. It was reported that recognition could be based on strong sense of familiarity relating to encoding specificity.

In a study titled "Intrusion in Episodic Memory: Reconsolidation or Interference?" researchers replicated the idea that free recall with a contextual reminder cue consolidates the human episodic memory. There was a high intrusion rate during recall & reconsolidation account was evaluated relatively to alternative account based on state dependent learning & interference. Experiment 1 wasn't straight forward; Experiment 2 used a highly salient context & Experiment 3 in which a critical assumption of the reconsolidation account that the target list is reactivated & destabilised during re-exposure of study context wasn't supported. Here, intrusion was explained in terms of cognitive effects like item-to-context binding & interference during retrieval highlighting state-dependent learning (Klingmuller et al., 2017).

In an experiment conducted by Tulving & Pearlstone on retrieval failure, there were participants presented with a series of words in categories like category of birds had a separate list & so had the category of animals. In the testing phase, participant was either asked to recall as many words as they can in any order (free recall) or from specific categories i.e., either from birds to animals (Cued recall). Here, the cued recall group performed better than free recall group highlighting that cues at the time of encoding & cues at the time of recall, if correspond or utmost remain same then recall would be better. The environmental retrieval cues promote memory accessibility & retrieval success (Frankland et al., 2019).

Lange-Kutter & more conducted a study in 2022 with a sample of 151 children (5-10 years). There was 3 x 3 grid formation which comprised of 3 different retrieved condition i.e., 1) same array as during presentation 2) one place at a time with placeholder 3) one place at a time without placeholder along with a control condition where individual shoes were of the same colour as the colourful places. Results showed that condition (3) was hardest to remember. Remembrance was better for places when placeholder was added & still better when spatial context of entire array was available. Also, unique shapes with distinctive contours & colours as placeholders optimised place memory the most suggesting that a greater number of distinctive cues of stimuli available at the time of encoding fosters & retrieval. Unfortunately, while place memory accuracy increased with age, but the reaction time didn't become faster.

Encoding specificity also encompasses state dependent memory which had been evidently demonstrated via the study conducted Seehagen & more in 2021 on 96 nine months old infants. They found excellent retention in infant of a deferred imitation task after 15 mins delay if their encoding state was identical & similar to their retention state. They failed to demonstrate retention if encoding & retrieval state differed. Hence, declarative memory of infants was heavily state dependent & their memory processing depended on memory cues. This can be understood as via the role played by sensory modalities from the time of birth which gradually develop in infant from olfaction to vision which make info encoding & retrieval more sensory dependent at various sensory state exposure. Similarly Steady & more conducted a study in 2019 on 96 children (Grade 2-5) demonstrating that with a developmental word reading model, incomplete & over simplified GPC (Grapheme-Phoneme Correspondence) representation become more context dependent with reading experience. Wang in 2023 highlighted in his paper that memory recall is better when encoding & testing environment are matched & background colour & videos are used. It was found that when participants smelled the same environment during encoding & retrieval, they recalled more words.

Hanly et al., 2017 performed a study on 89 children to explore the impact of visual displays on attention & learning of Atypical Autistic children. There were 2 groups who were shown videos (2 of story time & 2 mini lessons). Half videos had high visual displays (HVD) & half had none (No Visual Display or NVD). It was significant that presence of visual displays had a prominent impact on attention of all children but more on autistic children. It had an impact on learning from mini lesson whereby children received poorer scores in HVD comparatively with NVD lesson. More number of cues at the time of encoding promotes greater association of ideas to club in a schematic network which may lead to better recall or learning later.

In a recent study by Ostendorf et al., 2020 on 2nd (N = 25) & 5th (N = 16) Graders, it was interestingly determined whether auditory context dependent memory could be demonstrated in classroom using background noises. Across 2 experiments it was found that reinstatement of auditory context fostered memory performance for the subjects. Therefore, sounds, not just Musical notes, become a part of memory & hence can be effective contextual mnemonic cue. Ultimately, auditory contextual dependent memory effect was elicited by young children so teachers should be aware of such contextual auditory influence in classrooms & how info is stored along the focusing the teaching lesson.

Waiwod in 2018 conducted a study on 348 younger children comprising of 5 major shows. Each show followed a similar general script with options of details that varied in each show. There was a deviation in middle of the show. After a delay of 1 week, children were asked to recall the following i.e., 1st time, last time or the time which was different/unique. Some children received Mental Context Reinstatement (MCR). Primary & Recency time was not accurately recalled than the time which was different/unique. It was also found that MCR increased no. of experienced details in younger children across instances which served to activate children's memory for the script.

Sonne & more replicated their study of 2019 in 2021 with 124 children with 62 (35 months old) & 62 (46 months old). The 2 groups were subjected to the same or to a new experimenter after a week. It was found that 46 months old performed better when the experimenter was changed portraying a sensitivity to change &

an ability to update their knowledge relatively to 35 months old children. The recall better in 46 months old kids could be due to neuroplasticity where neurons are comparatively more efficient to encode & function relatively to 35 months old kids. Again, amnesia factor could be causative. The study couldn't highlight the prominent cues for spontaneous recall abandoning research gap.

Human Cumulative culture are also context dependent as stated by the study done via Wilks & more in 2021 on 154 children aged 3-6 years who were allowed to play a searching game (Find the Treasure). The puppet's endeavour elicited info about the contents of site searched which could be exploited to target rewarded locations & avoid unrewarded ones. There were 2 conditions i.e., Condition 1 in which puppet demonstration rendered transient info – boxes were opened, seen to be rewarded or not & then shut. In Condition 2, Puppets selected boxes were kept partially opened, rendering a visible cue to whether that site was rewarded. There were 3 trials of which performance of children in enduring cue condition demonstrated potential for cumulative culture but in transient info condition only older children depicted improved performance which could be due to more memory flexibility.

In 2020, Ma & more did research on 50 students comprising of different age group i.e., 1st Graders, 3rd Graders & 3rd Year College students who studied 2 wordlists. When words presented mixed, subjects were told to either restudy the words under intentional leaning condition or form list discrimination judgement via indicating the list from which each word had been originated. Results suggested that retrieval practice based on 'Episodic Context Reinstatement' paradigm exhibited a phase development trend in subjects relatively to restudy. The 'Episodic Context Reinstatement' (ECR) only exhibited memory retention for 3rd Graders & College students but not in 1st Graders. This could be typically because during early developmental years, children don't have mature episodic memory & cannot output memories according to context cues.

Imuta et al., in 2018 conducted a study on 197 five to six years old who were taught in the same class or on a field trip & were then assessed after 1-2 days at 1st, then after 6 months of gap. It was that learning context was more pronounced for older children wherein field trip produced more autobiographical memories than classroom, but children learned the same content in both contexts. Older children who learned in classroom, their autobiographical memory was predictive of the amount of info they recalled. Older children were more adept to effectively utilize the Mental Reinstatement to retrieve info which could be due to consolidating neuroplasticity at later stages of development.

Not only recall but student disability is also found to be Context dependent as per a study done by Cooc in 2018 on 15,462 10th Graders. Every student was uniquely featured under 2 different classrooms rendering an opportunity to observe how difference in students' behaviour, achievement & their teacher's characteristics can affect & influence when teachers disagreed in their judgment of student's disability. It was found that teachers disagreed more when students' behaviour varied across classroom. Prominently it was found that how disability is a Context dependent Social Context & this holds implications for how student is recognised to bestow special education. Hence, context dependent cues aren't only necessary for recall but also for identifying & promoting special education for differently abled. Teachers pick these cues in order to categorise & correspond student as per their need & aid.

Similarly empathetic response too, incorporates context dependence as per Vaish's article (2016) on Flexible concerns about Multidimensional & context dependent empathetic responding. Empathy has 2 vital facets of flexible empathetic responding i.e., Multidimensional, which is exhibited in response to various cues & context dependence which is regulated on contextual factors. It has been found that flexible empathetic responding relies significantly on Top-down processing, but the research are still narrow & hence we need more evidence to fill the gap.

The study titled "The Effect of Odour reinstatement on Children's Episodic Memory" conducted by Roos of Hjelmsater & more in 2015 on 106 children investigated whether odour reinstatement aids children's memory & increases the amount of info recalled from a prior experienced event children experienced a Vanilla odour during magic show & then were interviewed either 1 week or 6 months after the show. Half of the children experienced the same vanilla odour during the interview. Unfortunately, no odour effect was demonstrated via children compared to adult participants & in turn it (odour effect) reduced the children's rating of how strong their emotions were during the event. But the study failed to establish odour effect for the sake recall guided on the principle of Encoding Specificity.

Huber & more in 2020 conducted a study on thirty 48 months old children's memory for eBook content & traced objects after observational touch screen exposure comprising 3 conditions i.e., 1) Close mapping: touch screen input corresponded closely with output 2) Far mapping & 3) Observing screen recoding. Results highlight that interactivity on children's memory were influenced by multiple factors including level of interactivity, age & gender of child. Overall interaction did not always lead to memory benefits & when it did, it was on older children which can be due to more memory flexibility as mentioned earlier.

A study titled "Arbitrary but predictive cues support attention to overlook" was conducted via Luna & Sandhafer in 2021 on 100 (3-years old) children. Half of the children learned novel shape (biased feature) & texture (overlooked feature) categories with predictive cues & remaining half sample learned the same categories with non-predictive cues. Cues were rendered in Experiment 1 (N = 65) but were absent in Experiment 2 (N = 37). Results suggests those children in predictive cue condition consistently chose the texture much more often than children in non-predictive condition. But unfortunately, children in predictive condition didn't perform significantly better when test context matched training context in Experiment 1 as per encoding specificity. This could be possible because recent findings reveal that contextual cues are only needed when the cues are helpful for discrimination target objects (Badham et al., 2016) & high amount of discriminatory tendency may not be that efficient in 3 years old kids.

Crumb & more did a study in 2022 on 80 students dividing the participants into 2 conditions i.e., Congruent (taking notes via hand & then completing Quiz by hand or taking notes using a laptop & then completing Quiz online) & Incongruent condition (taking notes by hand & then take online quiz or taking notes using laptop & then complete the Quiz via hand. It was found that subjects who took notes via hand performed better on overall quiz than students who used laptops. The evidences failed to signify state dependent effects.

In 2019, Seddon did a study with a mainstream 11-18 secondary school students to probe whether Contextual memory impacts students recall during exams. For this, they were tested within their standard classroom environment & then were moved to different environment for 2nd test. Results highlights student performing statistically worse when tested in a different environment than their standard one Gender had no impact on the effects, however school years had i.e., year 7 student were the least affected. So, does it mean that children are at a disadvantageous state undertaking exams in a different context than the one in which they encoded the info? The answer remains still vague.

According to Keresztes et al., (2018), Hippocampal maturation drives our memory from Generalisation to Specificity. They emphasis generalisation at the expense of specificity persisting into middle childhood & adolescence. During this period, states like Recognition, regularities, forming stable representation of recurring episodes, predicting the structure of future events & building up new semantic memory could be prioritised over remembering specific episodes.

Recommendation

Although Encoding Specificity had found to be effective in some of the research (Sonne et al., 2019; Hipskind, 2020; Larzabal et al., 2018; Frankland et al., 2019; Waiwod, 2018) for efficient recall & retrieval but unfortunately odour effects weren't found effective for the recall. Multiple factors including level of interactivity, age & gender of child should be taken into consideration when such specificity is being taken into account. Studies demonstrate the principle being more 'Constructive' for older children than younger ones (Sonne et al., 2019; Wilks et al., 2021; Ma et al., 2020; Imuta, 2018).

As because encoding specificity plays a prominent role in recall, children can use this phenomenon to retrieve better during exams, like by trying to keep their encoding states (emotional & physiological) similar at the time of encoding & recall during exams. They can use the same stationary to utmost try keeping the context same from their end. Teachers can render students with similar (not exact) model papers to practice, to elicit repeatability of performance during exams.

Conclusion

Encoding Specificity is the tendency for human memory of info to be better recalled if related info (such as surrounding or physiological state) that is available when the memory is 1st formed is also available when the memory is being retrieved. Basically, it is divided into 2 types i.e., Context-Dependent Learning & State-Dependent Learning. Some researchers have found the highlights of the principle & others have probed its effective role in learning but unfortunately some found it fruitful only for older children. Encoding specificity had been found to correlate with Disability (Cooc, 2018) & empathy (Vaish, 2016) as well. But studies of Huber et al., 2020; Luna & Sandhafer, 2021; Crumb et al., 2022; & Seddon, 2019 did not found significant difference in their construct of measurement i.e., context/state dependent learning or recall.

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