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Efficacy of the Generation Effect for Promoting Learning of the Relationship of Graphic Symbols and Referents: An Initial Report.

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Abstract:

Learning the relationship between graphic symbols and their referents is important for individuals who communicate with graphic symbols. Speech language pathologists and educators frequently have insufficient time to devote to the learning needs of each student. The present study describes an efficacious learning procedure based on self-generation. This procedure is easily automated for student implementation, resulting in maximization of communication professionals' limited time and the possibility of learning and practice at home. Symbol-referent memory formation with self-generation is discussed in terms of deep-level processing.

Research Description

Communication fluency of graphic symbol users depends on how well the relationship between symbols and referents are learned. Procedures that promote deeper level processing may create elaborate engrams with multitudinous retrieval routes (Tulving & Craik, 2000) and greater long-term retention compared to those created through more superficial processing. Learning procedures utilizing deep processing may optimize symbol-referent learning.

The generation effect involves better memory for material generated by participants compared to experimenter supplied material. Better learning with generation may be due to more elaborate engrams with multitudinous retrieval routes. The generation effect became popular in the late 1970s (Jacoby, 1978; Slamecka & Graf, 1978). To illustrate the generation effect, Slamecka and Graf asked participants to generate words that were synonyms to a cue word. In the control, participants were given both members of the pair and asked to read the pair aloud. Generated words were remembered better than those read aloud. Researchers have demonstrated the robustness of the generation effect through replications.

Speech language pathologists (SLPs) and educators frequently have heavy case loads and minimal time to devote to students' individual needs. Primary objectives for beginning graphic symbol users may be promotion of symbol-referent learning. It would be desirable to have an automated learning method because many SLPs and educators have insufficient time to devote to each student's communicative needs. Home practice is believed to solidify learning. Hence, it would also be advantageous for automated learning to be implemented at home. Moreover, it would be beneficial for the automated procedure to capitalize on learning that promotes deep-level processing and long-term retention.

Purpose: Based on need for an automated learning procedure and the robustness and long-term memory implications of deeper processing via the generation effect, the purpose of the present study was to develop and test the efficacy of automated procedure based on the generation effect for teaching the relationship between symbols and their referents. Paired-associate learning, a procedure employing more superficial processing was used for comparison. The procedure was named "self-generation" because it was automated once learned.

Method

Participants: Non-disabled participants consisted of 12 college students and 12 third graders. It was originally anticipated that complimentary disability groups to those above with little or no functional speech would also be used; however, despite rigorous recruitment efforts, only two disabled participants were tested. One was a seventh grader with cerebral palsy and some attention deficit disorder, and the other was a sixth grader with a learning disability and speech apraxia.

Symbol and referents: Software was developed for presenting symbols and referents on PRC's Pathfinder. To reduce confounding from iconicity, symbols were constructed from lexigram elements randomly selected and overlaid. Two levels of symbol complexity were used. Low complexity symbols consisted of two lexigram elements and high complexity of four elements. Referent assignment used a random procedure. Referents were four-letter words within a third-grader's vocabulary.

Acquisition: Two self-generation conditions were used. One entailed symbol generation. The other entailed referent generation. In both conditions, the self-generation response was depression of any key on the Pathfinder. For symbol generation, key depression resulted in lexigram generation through a process of appearance and overlaying of elements on the Pathfinder's LCD screen. For referent generation, key depression resulted in construction of the referent through appearance and addition of letters on the LCD screen. For paired-associate conditions, the first key depression caused one component of the symbol-referent pair to appear. The second depression caused the other component of the pair to appear next to the first component.

Memory Testing: Retention testing was conducted immediately, 24 hours and 1 week after symbol-referent presentations. Testing consisted of presentation of lexigram and identification of its referent from five choices.

Results

An analysis of variance was performed on the mean number of correctly identified symbols and referents for the non-disabled groups. Main effects of tests (F=8.52, p=0.0008) and self-generation condition at the 0.1% level (F=1.93; p=0.096) were found. Performance of college students and third graders did not significantly differ. The main effect of tests is shown in Table 1. Collapsed over participant groups and conditions, performance on the second and third tests were significantly different from the first test (Tukey least squared test, t=2.68, p=0.01; t=4.06, p=0.0002, respectively). Performance on the second and third tests did not significantly differ.

Table 1 - Mean number of correctly identified symbols and referents collapsed over conditions and participant groups.

Test 1 (Immediate)	**Test 2 (24 hours)**	**Test 3 (1 week)**
39.53	34.28	31.56

Shown in Table 2 is mean performance for each condition during each retention interval. A Tukey least squared test found best immediate retention for the paired-associate control for the referent generation condition. Immediately after acquisition training, paired-associate referent control performance was significantly better than the lowest performing condition, high-complexity symbol generation (t=2.04, p=0.042). The paired-associate referent control's memory advantage, however, was transitory and faded after a week. After a week, the best performance was in the referent-generation condition and the worst in high complexity symbol generation and paired-associate controls. Referent generation performance was significantly better than high complexity symbol generation (t=2.09, p=0.038) and better than paired-associate control for high complexity symbol generation condition after 1 week (t=1.87, p=0.062). The paired-associate control for the referent generation did not differ significantly from low or high complexity symbol generation conditions or from paired-associate controls for either of these symbol generation conditions after 1 week. A similar retention pattern was found for disabled participants.

Table 2 - Mean number of correctly identified symbols and referents for each condition and retention interval.

Condition	Test 1 (Immediate)	Test 2 (24 hours)	Test 3 (1 week)
Low Complexity Paired-associate Control	39.12	35.25	28.28
Low Complexity Symbol Generation	38.19	35.84	33.06
High Complexity Paired-associate Control	35.80	29.41	29.09
High Complexity Symbol Generation	38.97	29.29	28.11
Referent Paired-Associate Control	44.82	36.97	32.23
Referent Generation	40.23	38.91	37.43

Conclusion and Clinical Implications

The best long-term retention was found with referent self-generation. This is consistent with self-generation involving deeper level processing and more elaborative engrams with multitudinous retrieval routes (Tulving & Craik, 2000). A viable referent generation processing scenario involves participant formulation of mental guesses as to the actual word being constructed. Although attempts were made to minimized iconicity, participants were unaware of this and probably used the symbol to guide guessing of the referent being constructed. Guiding may have created and solidified connections between symbols and their referent. Some third graders said the referent aloud before it was completely generated. This is consistent with guess making and deeper-level processing. In contrast, no opportunity for mental guessing and deeper processing existed in the paired-associate control for the referent generation condition because the referent was presented in its entirety. Also, symbol generation was based on overlaying randomly determined lexigram elements, creating a novel symbol. Hence, there was no logical or meaningful basis for mental guessing the conformation of the symbol being generated.

From a clinical perspective, promotion of learning the relationship between symbols and referents would be best accomplished through a procedure based on deeper level processing such as with self-generation. Although the present procedure was implemented on a Pathfinder, it should be easy to adapt commonly available software to simulate self-generation with symbols other than lexigrams. The conference discussion will examine deeper-level processing of different symbol types using the functional classification of Fuller, Lloyd, & Stratton (1997). Processing and symbol characteristics will be discussed based upon data from the present study (e.g., arbitrary or opaqueness, complexity) and other research.

References

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