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Recombinative generalization: Some theoretical and practical remarks

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A primary goal of behavioural interventions aimed at teaching skills is to establish generative responding. Recombinative generalization, which has been defined as the demonstration of novel arrangements of previously established linguistic units, is a process involved in generative responding. Successful recombinations contribute to the development of a functional, not rote, language repertoire that often generalizes across stimuli, responses, and time. Although research on recombinative generalization began some 80 years ago, understanding of this process is still not complete. Furthermore, programming for successful recombinations when teaching language and reading to typically and not-typically developing children is still minimal. The early recombinative generalization studies worked on a "miniature linguistic system"; the referential stimuli (words) were arranged in a pattern that included all possible combinations of the dimensions of interest. Matrix training approaches to recombinative generalization showed how to produce functional language. In the present paper, I will (1) review research on recombinative generalization, (2) discuss conditions necessary for successful recombinations, and (3) make suggestions for practice relating to recombinative generalization. The discrimination required for successful recombinations fits well in the definition of "abstraction": a discrimination based on a single property of a stimulus, independent of other properties; thus, generalization to other stimuli with that property. Abstraction is demonstrated when an individual correctly identifies untrained stimuli based on property of interest. Recombinative generalization contributes to achieving functional language. Further research on recombinative generalization will broaden the understanding of basic processes and their application to teaching language and early literacy skills.

L'objectif primaire des interventions comportementales qui visent à enseigner des compétences est d'établir une génération de réponse. La généralisation recombinante, définie comme étant une démonstration de nouveaux arrangements des unités linguistiques établies préalablement, est un processus qui implique la génération de réponse. Les recombinaisons réussies contribuent au développement d'un répertoire de langage fonctionnel, pas mécanique, qui se généralise souvent à travers les stimuli et le temps. Même si la recherche sur la généralisation recombinante a débuté quelque 80 ans plus tôt, la compréhension de ce processus est toujours incomplète. De plus, la programmation pour des recombinaisons réussies est encore minimale pendant l'enseignement d'une langue ainsi que de la lecture à des enfants qui se développent typiquement et des enfants atypiques. Les premières études portant sur la généralisation recombinante ont porté sur le «système linguistique miniature»; les stimuli référentiels (les mots) étaient arrangés selon un patron qui a inclus toutes les combinaisons possibles des dimensions d'intérêt. Les approches fondées sur une matrice d'entraînement pour la généralisation recombinante ont montré une production de langage fonctionnel. Dans le présent article, l'auteur: (1) révisera la recherche sur la généralisation recombinante, (2) discutera les conditions nécessaires pour la réussite des recombinaisons, et (3) proposera des suggestions pour la pratique reliées à la généralisation recombinante. La discrimination requise pour la réussite des recombinaisons entre bien dans la définition de «l'abstraction»: une discrimination basée sur la propriété unique d'un stimulus, indépendamment des autres propriétés; d'où la généralisation à d'autres stimuli avec la même propriété. L'abstraction est démontrée lorsqu'un individu identifie correctement les stimuli sans entraînement en se basant sur la propriété d'intérêt. La généralisation recombinante contribue à parvenir au langage fonctionnel. La recherche future sur la généralisation recombinante élargira la compréhension des processus de base et de leur application à l'enseignement d'une langue et aux capacités précoces d'alphabétisation.

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Una meta fundamental de las intervenciones conductuales que buscan enseñar habilidades es establecer respuestas generativas. La generalización recombinatoria que se define como la demostración de arreglos novedosos de unidades lingüísticas previamente establecidas, es un proceso que toma parte en las respuestas generativas. Las recombinaciones exitosas contribuyen al desarrollo de un repertorio funcional del lenguaje, no mecánico, que con frecuencia se generaliza a través de los estímulos, las respuestas y del tiempo. Aunque la investigación acerca de la generalización recombinatoria comenzó hace aproximadamente 80 años, el proceso no se entiende completamente. Más aún, la programación de recombinaciones exitosas para enseñar lenguaje y lectura a niños con desarrollo típico y con desarrollo atípico, es todavía mínimo. Los estudios iniciales sobre generalización recombinatoria se referían a "sistemas lingüísticos en miniatura"; los estímulos de referencia (palabras) se organizaban en una pauta que incluía todas las posibles combinaciones de las dimensiones de interés. Los enfoques de matriz de entrenamiento para investigar la generalización recombinatoria mostraron que produce lenguaje funcional. En el presente artículo, la autora: (1) revisa la investigación sobre generalización recombinatoria, (2) discute las condiciones necesarias para las recombinaciones exitosas, y (3) presenta sugerencias para la práctica relacionada con la generalización recombinatoria. La discriminación que se requiere para combinaciones exitosas encaja bien en la definición de "abstracción": una discriminación basada en una sola propiedad de un estímulo independiente de las otras propiedades; en esta forma ocurre la generalización a otros estímulos que posean esa propiedad. La abstracción se demuestra cuando un individuo identifica correctamente sin entrenamiento estímulos basados en esta propiedad que nos interesa. La generalización recombinatoria contribuye al logro del lenguaje funcional. Investigaciones adicionales sobre la generalización recombinatoria aumentará nuestra comprensión de los procesos básicos y de su aplicación a la enseñanza del lenguaje y a las habilidades tempranas de lecto-escritura.

INTRODUCTION

Learning has been defined as a process during which behaviour is added to an organism's repertoire (Catania, 1998). Sometimes the result—a relatively permanent change in behaviour—is a function of direct teaching of skills of interest, but more often, it is a function of discovering, based on what has been taught, relations between stimuli or generalizing the newly acquired skills to different stimuli and behaviours. Indeed, a primary goal of behavioural interventions aimed at teaching skills is to establish generative responding (Bergman & Gerdtz, 1997; Lord & McGee, 2001). Generative responding refers to emitting behaviours that have not been previously demonstrated by an individual and have not been directly trained, but may be related to other, trained responses (Schumaker & Sherman, 1970). In the context of language, generative responding means comprehending questions, requests, and comments (receptive language) that an individual has not heard before and producing utterances (expressive language) that have not been produced before. Both skills are crucial in the development of flexible and functional, not stereotypical and rote, language. Some typically developing children and many persons with developmental disabilities have great difficulties with achieving generative responding. It is, thus, a formidable task for researchers and practitioners to understand basic processes responsible for generative responding. Previous research indicates that recombinative generalization is involved in generative responding (Peterson, Larsson, & Riedesel, 2003).

Recombinative generalization has been defined as "differential responding to novel combinations of stimulus components that have been included previously in other stimulus contexts" (Goldstein, 1983, p. 281). When familiar stimuli are recombined in novel ways and stimulus elements continue to exert precise and appropriate control over corresponding portions of the response, recombinative generalization has occurred (Wetherby & Striefel, 1978). In the context of language, recombinative generalization refers to the demonstration of novel arrangements of previously established linguistic units (Goldstein, 1993). Although research on recombinative generalization began some 80 years ago, understanding of this process is still not complete. Furthermore, programming for successful recombinations when teaching language and early literacy skills to typically and not-typically developing children is minimal. In the present paper, I will: (1) review research on recombinative generalization, (2) discuss conditions necessary for successful recombinations, and (3) make several suggestions for programming recombinative generalization.

RESEARCH ON RECOMBINATIVE GENERALIZATION

The recombinative generalization literature includes two types of studies: those in which the recombined units are whole words and those in which the units are smaller than words (e.g., syllables). Both groups of studies will be discussed in this section.

The early recombinative generalization studies originated from Esper's (1925) work on a "miniature linguistic system" (as reported by Wetherby, 1978, p. 401). In this system, the referential stimuli (i.e., words) are arranged in a pattern that includes all possible combinations of the dimensions of interest. For example, if the dimensions of interest are colour and shape, the words representing different colours are placed in rows and the words representing different shapes are placed in columns. Thus, a matrix is formed in which separate cells, the intersections of each row and column, contain a two-word utterance referring to a colour–shape combination (e.g., green square). Within the whole matrix, there is an overlap between the two-word utterances because each colour is paired with each shape (e.g., green square, green circle, green triangle). In Esper's study, four colour and four shape stimuli were used, thus the whole system consisted of 16 colour–shape labels. Esper showed that participants, who were trained to expressively name 14 stimuli using appropriate labels, identified correctly the 2 untrained colour–shape combinations. However, when the labels in cells did not correlate with the colour and shape names (i.e., each stimulus combination received a different, unsystematically chosen name), such generalization did not occur (Esper, 1925, 1933). Thus, the orderliness of the miniature linguistic system, as shown by the overlap in the labels, facilitated recombinative generalization. What Esper did not examine was how many labels had to be taught minimally and in what order to produce novel responding.

The results of studies by Foss (1968a, 1968b), Striefel, Bryan, and Aikins (1974), Striefel and Wetherby (1973), and Striefel, Wetherby, and Karlan (1976) delineated the training conditions necessary for recombinative generalization to occur. Those researchers distinguished between diagonal and stepwise training, which differed in the selection of training items. In diagonal training, the participants were trained on labels that did not have an element in common (e.g., red circle, yellow triangle, blue square). Stepwise training, in contrast, provided an overlap among the stimulus components (e.g., red circle, red triangle, yellow triangle, yellow square, blue square, blue heart). The combined results of the studies showed that only the stepwise training resulted in correct labelling of the untrained stimuli, presumably by establishing stimulus control of both elements in each two-word utterance (Striefel et al., 1976). Thus, overlap among stimulus components is vital because it facilitates subjects making the discriminations necessary to demonstrate recombinative generalization. The stepwise training is also called matrix training.

Recombinative generalization of whole words was also investigated by Goldstein and colleagues (Goldstein, 1983; Goldstein, Angelo, & Mousetis, 1987; Goldstein & Mousetis, 1989). The researchers applied matrix training to a more complex language system, one that included three dimensions. Goldstein and Mousetis, for example, constructed an object–preposition–location matrix. Three object labels were combined with five prepositions and six locations, yielding 90 three-word utterances (e.g., "button under cabinet"). The participants identified expressively and receptively all three objects, two prepositions, and three locations before training. Within the matrix, there was a submatrix consisting of the known words (18 three-term utterances) and three other submatrices of unknown propositions and locations. Training, which consisted of modelling and differential reinforcement of correct responses, began with a single item from the submatrix of known words. The participants were to answer the experimenter's question "What did I do?" using a three-word utterance (e.g., "penny on rug"). Upon reaching mastery of this utterance, three participants with mental retardation responded correctly to the remaining 17 items. Training of one item from the other three submatrices resulted sequentially in generalization to the remaining items from those matrices. In sum, recombinative generalization accounted for 95–98% of responses learned. The authors point out that the positive results might have been heightened by teaching recombinations of known items before introducing unknown items (Goldstein et al., 1987; Goldstein & Mousetis, 1989).

Lutzker and Sherman (1974) investigated generalized use of two sentence forms corresponding to subject–verb agreement (e.g., "Boy is running" versus "Boys are running") in response to appropriate pictures. The authors pretrained expressive labelling of the pictures, which depicted either a single object or two objects, as well as different activities. The main training consisted of teaching use of the appropriate auxiliary verb when answering the question "What's happening?" in a complete sentence. Four of five children began to produce correct sentences in response to untrained pictures following training. Although the researchers did not use matrix training, Wetherby (1978) pointed out that their work could be analysed within the miniature linguistic system framework because of the repetition and overlap among trained units (e.g., "boy is fishing," "boys are fishing," "cow is running," "cows are running"). In summary, when two- and three-word phrases and simple sentences are trained in the context of several and varied stimuli that contain overlapping components, the emergence of novel labels in response to new arrangements of the trained stimulus components demonstrates recombinative generalization.

The role of recombinative generalization in teaching early literacy skills (e.g., naming printed words or spelling) has been shown in studies examining recombination of within-word units. Within-word units are syllables, onsets (the consonant or consonant cluster, which precedes the vowel in a syllable) or rimes (the vowel and succeeding consonants), morphemes, and individual phonemes (Bernstein & Treiman, 2003).

A series of studies by Guess and colleagues demonstrated that parts of words could be recombined (e.g., Guess, 1969). Guess, Sailor, Rutherford, and Baer (1968), for example, taught a girl with mental retardation to correctly label objects when they were presented singly or in pairs. The trained expressive responses to objects in pairs contained /s/ at the end (e.g., "cups"). The generalized use of the plural morpheme /s/ emerged following training of a several singular and plural labels. The generalization results can be conceptualized as abstraction of the plural morpheme /s/ in the presence of more than one object. Thus, a novel stimulus configuration—several of the same object (the participant had learned to name a single object)—resulted in a recombination of the name of the object with the /s/.

Mueller, Olmi, and Saunders (2000) investigated recombinative generalization of within-syllable units (i.e., onsets and rimes) using matrix training. Three kindergartners were taught, using a match-to-sample procedure, to select several printed words containing overlapping onsets and rimes (e.g., mat/sat/sop/sug) upon hearing those words. The researchers were interested in whether the children would correctly select untrained printed words formed by rearranging letters of the trained words (e.g., mop/mug). The three participants demonstrated generalization after little training (on one or two word sets out of six). This performance indicates the recombination of onset and rime units. The researchers also asked the participants to name the 21 words used in the study before and after the match-to-sample training. None of the children read any of the words at the beginning of the study. At the end, the participants read 65%, 0%, and 20% of the words. The word naming results for the first participant suggest, similar to the de Rose, de Souza, and Hanna (1996) study, the development of control by smaller units (individual phonemes in this case). Because there was a considerable overlap in letters among the study words (e.g., "mop" and "map"), the first participant's word naming was most likely under the control of all of the letters. Such performance is not common in beginning readers as they often name words based on the first letter only (Ehri, 1992).

Finally, Goswami (1993) showed that when young prereaders were taught to read a "clue" word (e.g., "bug"), they were more likely to read correctly untrained words with a rime that overlapped with the "clue" word (e.g., "rug"). However, the generalization results were modest, potentially due to a lack of prerequisite skills for complete generalization (i.e., cue words containing the initial consonants were taught). Goswami (1986) referred to the children's performance as reading by analogy, but the participants' performance was clearly an example of recombination.

To conclude this section, recombinative generalization is a process involved in generative responding in language acquisition and in early literacy skills (de Rose et al., 1996; Wetherby & Striefel, 1978). Matrix training approaches to recombinative generalization have been shown to produce functional language and this approach appears to hold promise for learning more about basic processes involved in language acquisition.

CONDITIONS NECESSARY FOR SUCCESSFUL RECOMBINATION

One condition that has been shown to result in generalized responding is conditional discrimination (Saunders & Spradlin, 1990, 1993). Conditional discrimination is a discrimination in which responding to a certain stimulus is reinforced depending on an additional—conditional—stimulus (Catania, 1998; Saunders & Williams, 1998). For example, a child may say "cat" when presented with the printed word "cat" and asked "What does it say?" or he might say "c" when asked "What letter does this word start with?" Which response to a printed word "cat" is reinforced depends on the teacher's question.

In order to successfully recombine multiple-term phrases (e.g., blue cup, yellow plate), a child must learn multiple-term conditional discrimination. In the example given, the conditional discrimination would be two-term (adjective-noun). The conditional discrimination is possible when, during teaching of "blue cup" and "yellow plate," distracters for both terms (adjective and noun) are present (i.e., blue cup, yellow cup, blue plate, yellow plate). If the discriminative stimulus is "blue cup" and on the table there are a blue cup, a yellow cup, and a blue plate, the response becomes conditional when the adjective determines which cup is correct (i.e., the blue cup). In other words, the adjective "blue" is a conditional stimulus. A correct conditional discrimination is only made when both terms are simultaneously discriminated to produce one correct response. Thus, acquisition of multiple-term conditional discriminations results in attending to all terms comprising the discriminative stimulus. If, then, those terms are recombined in novel ways (e.g., blue plate, yellow cup) and stimulus elements continue to exert precise and appropriate control over corresponding portions of the response, successful recombination has occurred. Peterson et al. (2003) show examples of teaching two-term (e.g., subject-action), three-term (e.g., action-adjective-object), four-term (e.g., subject-preposition-adjective-object), and five-term (subject-action-preposition-adjective-object) discriminations. In practice, effective conditional discrimination may be trained to the eight-term level (e.g., adjective-adjective-subject-action-adverb-preposition-adjective-object).

The discriminations required for successful recombinations seem to fit well the definition of "abstraction," as proposed by Catania (1998): Namely, abstraction is a discrimination based on a single property of a stimulus, independent of other properties; thus, generalization to other stimuli with that property (p. 250). Abstraction is demonstrated when an individual correctly identifies untrained stimuli based on the property of interest (e.g., if the property is "redness," abstraction is shown when a child identifies a red, and not a blue, ball the first time the child sees the red ball). Saunders (2002) distinguishes between visual abstraction (discrimination based on a visual property of a stimulus) and auditory abstraction (discrimination based on an auditory property). Visual and auditory abstractions seem to play a role in the development of early literacy skills. That is, in order to establish a basic reading repertoire, beginning readers must name printed words they have been taught and words they have not previously encountered (Ehri, 1991). Prereaders are more likely to demonstrate these performances if they master the alphabetic principle (Foorman et al., 2003; Thompson, 1999). The alphabetic principle refers to "useable knowledge of the fact that phonemes can be represented by letters, such that whenever a particular phoneme occurs in a word, and in whatever position, it can be represented by the same letter" (Byrne, 1998, p. 313). Thus, in the next section, I discuss the role of visual and auditory abstraction in the development of the alphabetic principle.

Visual abstraction involves recognizing individual printed letters or letter combinations within the complex, whole-word stimuli (Saunders, Johnston, & Brady, 2000). For example, a student is shown the printed word "six" and taught to select printed words that begin with the same letter (e.g., "sat, sick, set" and not "pat, pick, pet"). If, later, on a test, when presented with the written word "six," the student independently selects the untrained words "simple, sage, sill" and not "pimple, page, pill," the student would demonstrate visual abstraction of the printed letter "s." When investigating the acquisition of the alphabetic principle, the visual part, as compared to the auditory part, of the letter–sound relation has received little attention from practitioners and scientists (Saunders et al., 2000). One reason for this might be that teachers and researchers assume that students who discriminate printed letters presented in isolation can also focus on individual letters or letter combinations within whole words. However, that is sometimes not the case, especially with young prereaders or individuals with mental retardation (NICHD, PO1 HD18955-18S1A1; Snow, Burns, & Griffin, 1998).

Saunders and colleagues (2000) reported that typically developing prereaders showed at least 90% accuracy at matching individual letters. In contrast, their accuracy on matching consonant-vowel-consonant (CVC) words that differed only in the initial letter was sometimes at chance levels. The children's responding did not indicate that they visually abstracted the initial consonant, that is, made a discrimination based on this property of the written stimuli. The authors concluded that failing to isolate individual letters embedded in words could compromise linking appropriate phonemes to those letters, thus demonstrating the alphabetic principle.

Similarly, McCandliss, Beck, Sandak, and Perfetti (2003) asserted that focusing attention on each individual letter within a word may play an important role in learning to name and identify novel words. The authors supported their assertion by investigating the effectiveness of an instructional programme that taught children to form and read words by manipulating a single letter in a previously constructed word. A child was, for example, taught to change "sat" to "sap" to "tap" to "top," etc and to name those words. The authors attributed positive effects of the intervention, in part, to the fact that the programme trained the children to attend to each letter and link it to the appropriate phoneme. However, this study did not provide empirical evidence for this claim because the authors did not specifically evaluate the role of visual abstraction.

Finally, Byrne (1992) investigated the differences in learning to name printed words that were visually more similar (e.g., rat, ran, rag) or less similar (e.g., two, boo, you). The results showed that the participants learned the less similar words more readily and with fewer mistakes. The authors concluded that the difficulties in naming similar words might have been related to the visual, not auditory, resemblance and, potentially, to the children's lack of skill in focusing on individual letters. This study provides indirect evidence that if children do not abstract individual letters within a word, they might not read similar words correctly. In summary, visual abstraction is a component of learning the alphabetic principle. Although there are few studies on the role of visual abstraction, this skill seems to be logically necessary for learning to name novel words (Snow et al., 1998). However, it is not sufficient. Visual abstraction must be accompanied by auditory abstraction if children are to master early reading skills (Byrne, 1992).

Auditory abstraction involves recognizing individual sounds or sound combinations within a spoken word (Saunders, 2002). For example, a student is taught that the spoken words "mat, milk, mouth" start with the same /m/ sound and that "sat, silly, sandwich" all start with the same /s/ sound. If, on the test, the student responds correctly to the question: "Which word starts with the same sound as 'mat,' is it 'mum' or 'sum'?", the student would demonstrate auditory abstraction of the sound /m/. Thus, following Catania's (1998) definition of abstraction, auditory abstraction is a discrimination based on a single phoneme in a word, independent of other phonemes, so there can be generalization to other words with that phoneme. In terms of reading, if children learn to break spoken words into smaller units and to relate those units to printed letters within words, they will be demonstrating the alphabetic principle (Murray, 1998).

Traditionally, individual phonemes have been the starting point in teaching children to read (e.g., Buchanan, 1973). More recently, however, researchers have shown that larger sound segments (e.g., onset and rime) might be abstracted by children earlier than individual phonemes (Treiman, 1992; Treiman & Zukowski, 1996). In a syllable, the term "onset" refers to the initial consonant and "rime" to the vowel and subsequent consonants (e.g., in "run," "r" is the onset and "un" is the rime) (Bernstein & Treiman, 2003). Consequently, studies examining the role of auditory abstraction in the development of the alphabetic principle focused on onsets and rimes.

Byrne and Fielding-Barnsley (1989, 1990, 1991, 1993, 1995) have conducted a series of experiments investigating the conditions necessary for mastery of the alphabetic principle. They mainly investigated onset sounds. In the 1989 study, for example, the researchers first taught 12 typically developing preschoolers to name two written words ("mat" and "sat"). Then, the researchers administered segment identity training, which consisted of teaching each child that a testing word (e.g., "mum") has the same onset as the training word (e.g., "mat"). Five children mastered the segment identity task, but none performed correctly on the transfer task (answering the question: "Does this say 'sum' or 'mum'?" when presented with the written word "mum"). Finally, the children were trained on letter–sound relations. That is, they were taught that the letter "m" corresponds to the sound /m/ and the letter "s" to the sound /s/. All 12 children learned this relation. During the next transfer test, six children showed generalization. Five of those children mastered both segment identity and letter–sound correspondence training. From this and other studies in the series (e.g., Byrne & Fielding-Barnsley, 1990, 1991), the authors concluded that the two skills necessary for the development of the alphabetic principle were segment identity and letter–sound relation.

Segment identity is auditory abstraction. That is, segment identity training taught the children to isolate the onset from the rest of the word and to discriminate among words based on their onsets. The reported studies also showed that once children master auditory abstraction for a particular phoneme in a particular position, they are likely to generalize this skill to other phonemes in other positions (Byrne & Fielding-Barnsley, 1990, 1991). However, it appears that auditory abstraction is not sufficient for mastery of the alphabetic principle. It needs to be supplemented by direct letter–sound training (Fielding-Barnsley, 1997). Both skills in combination seem to promote acquisition of the alphabetic principle and early reading skills.

Saunders (NICHD, PO1 HD18955-18S1A1) also examined conditions necessary to establish the alphabetic principle. Regarding onset abstraction, the researchers taught five typically developing kindergartners and three adults with mental retardation (MR) to select the printed letters "m" or "s" corresponding to the onset sound of several spoken CVC words beginning with those letters. Essentially, the researchers trained segment identity and letter–sound correspondence at the same time. All of the children and two adults with MR readily selected the letter corresponding to the onset sound of words they had not been trained on (NICHD, PO1 HD18955-18S1A1), while one adult with MR required some additional training before generalization was shown (Vaidya & Saunders, 2000). Those results clearly indicate abstracted stimulus control by the onset sound, which is a component of the alphabetic principle.

In the Mueller et al. (2000) study, auditory abstraction of both onsets and rime units was investigated in the context of selecting novel printed words upon hearing them read. Two children demonstrated generalization after training on one set only and the third child after training on two sets. All three children continued to select untrained words throughout six word sets. This performance indicates that the children abstracted onset and rime units and demonstrated the alphabetic principle. The skills that the children had to master to select untrained words were: (1) discriminating letters within written words, (2) discriminating phonemes within spoken words, and (3) relating those phonemes to printed letters. The results of Mueller et al. were reproduced using adults with mental retardation by Saunders, O'Donnell, Vaidya, and Williams (2003).

Goswami (1986, 1993) and de Rose et al. (1996) also demonstrated, although they did not directly assess, the role of auditory abstraction in early reading. De Rose et al. showed that three of seven children who were taught to read 51 words, read correctly at least 65% of the 45 untrained words. The untrained words were constructed by rearranging the syllables of the training words. Thus, correct performance on the generalization task indicated that the children learned that spoken words consist of syllables (i.e., auditory abstraction) and that those syllables correspond to specific letter combinations no matter in which word they occur or in what position. The three children's performance demonstrated the alphabetic principle.

To conclude this section, two conditions that seem to be necessary for successful recombination of whole words and within-word units are mastery of multiple-term conditional discrimination and ability to visually and auditory abstract.

SUGGESTIONS FOR PROGRAMMING RECOMBINATIVE GENERALIZATION

Teaching in a way that promotes recombinative generalization is very important because of its role in generative responding. The most important suggestion is to *programme* for recombination. One way to achieve this is to teach with the use of matrix training, which ensures that the trained words incorporate all of the test-word components. Matrix training can be used for whole-word or within-word unit recombinations and correct recombinations may be facilitated if the matrix consists in part of known items. The second suggestion is to not overlook the role of visual and auditory abstraction in basic literacy skills. Reading/writing of novel words will be possible if the child learns that a spoken/written word consists of smaller units (e.g., syllables), and that those units correspond to specific letter combinations, no matter what their position. Furthermore, successful recombinations may be hastened by establishing multiple-term conditional discrimination performance. Before each multiple-term discrimination is taught, each component term should be taught until generative. Lastly, successful recombinations may be promoted if, during teaching, equivalence classes are formed, especially in the context of reading and writing. Thus, procedures that facilitate development of relations between printed words, dictated words, and environmental events or their corresponding pictures should be used in teaching.

To summarize, recombinative generalization contributes to achieving functional language. Learning more about this process is important for both researchers and teachers. For a researcher, a child's correct identification of untrained words/phrases (in an expressive or receptive task) indicates that this child's responding is under the control of small units that were not presented independently, but rather developed from larger units (Skinner, 1957). For a teacher, the same performance indicates that this child does not always have to be taught to respond to every single novel stimulus, but rather that generative responding might emerge. Further research on recombinative generalization will broaden the understanding of basic processes and their application to teaching language and early literacy skills.

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