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Role of Cued Speech in the Identification of Words by the Deaf Child: Theory and Preliminary Data[1]

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The acquisition of reading poses major problems in a relatively important proportion of hearing children. In the majority of cases, however, ordinary instruction permits the attaining of levels of reading compatible with the academic and social requirements with which they are confronted. In the case of the deaf child, the situation is much more unfavorable. A survey carried out in Great Britain bearing particularly on a sample of the population of deaf adolescents finishing school (hearing loss > 85 dB) showed that their median level of reading was of the order of seven and one-half years (Conrad, 1979).

This result confirmed other established precedents in the United States (Wrightstone, et al, 1963: Di Francesca, 1972). It can be agreed that reading does not attain a functional level until toward the end of primary school, at about the age of eleven years.

Following this criterion, only five out of the 205 profoundly deaf adolescents examined by Conrad (1979), and 128 of the deaf adolescents aged 15 and 16 years of the sample of Wríghtstone et al (1972), were functional readers.

The idea of deficiency in reading does not have the same significance for the deaf and the hearing. The hearing person who is a poor reader has no difficulty in understanding in the oral form. The distinction between primary linguistic competence, which will be consistent with the comprehension of the spoken word, and secondary competence, which will be specifically linked to the written text, is central to the context in which we would like to place this discussion. The problems of a part of the hearing who have reading difficulties could be limited to problems at the secondary level.

The root of the difficulties of the deaf child who does not understand a written text are very often tied to limitations at the level of his knowledge of the language. This distinction is far from being purely academic. It specifies the exact nature of the problems and, thereby, points to conceivable remedies. The principal problem the deaf child encounters in facing a written text is that most of the time he has a general linguistic deficit. The best way to help him to read better is to teach him the language.

The general linguistic deficiency of the deaf child also exerts a negative influence at the level of acquisition of adequate reading procedures. The alphabet has a phonographic character; that is to say, there exists a relationship between the orthographic segments (letters and groups of letters) and the segments of the spoken language. This property permits the hearing child to identify the words he knows orally even when he encounters them in written form for the first time. This procedure for identification cannot evidently be utilized in a logographic system because, in this case, it is obviously not possible to assemble a phonological code which would allow access to the lexicon. For example, the identification of the Arabic digit "3," which is a logogram, can only be global and direct, whereas that of the corresponding orthographic version "three", can be both direct and global if the subject has developed an adequate orthographic code, and also indirect, through phonological assembling.

Some reading theoreticians have recently proposed models which assign to the procedures of phonological assembling a major role in the acquisition of that skill (see Ehri, 1980; Liberman, 1983; Jorm & Share, 1983; Frith, 1985). The main point of the argument consists of saying that the good reader possesses a wide vocabulary of words that he is capable of identifying without using phonological assembling procedures. This vocabulary would be developed as a result of encounters with written words that lead to their identification. The capacity for assembling phonological codes aside from the orthography gives the reader the possibility of multiplying these successful encounters because that skill makes him autonomous, that is, capable of identifying words without the aid of either the teacher or the context. This is feasible in a phonographic system (to identify the written word "three," for example), but impossible in a strictly logographic one (the

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digit "3"). In the last case, the intervention of the environment or the teacher or the context is indispensable for identification.

These ideas have important implications in the domain of the acquisition of reading in the deaf child. As we have just said, the capacity of assembling phonologic codes makes the hearing child an "autonomous reader," and through that helps him in the task of learning to read. This is possible only because this child possesses a phonologic path to his internal lexicon which results from his normal linguistic development in oral language. If that were not the case, phonological assembling procedures would be totally useless for written word identification. Now, this is in part the situation of the deaf child. For him, the phonologic path to his lexicon is severely limited. This makes the task of reading acquisition equivalent to that of the learning of an entirely arbitrary list of associated pairs--each written word must be paired in memory with its meaning. This is indeed what happens in a pure logographic system: the link between the digit "3" and its meaning is arbitrary, and the only way to learn it is "by heart." It is perhaps useful to add that the link between the phonological code /θri/ and its meaning is also totally arbitrary, but gained through multiple uses in communication. However, the role of phonology in reading acquisition exists because, prior to learning to read, this link has been established. It can, consequently, be exploited.

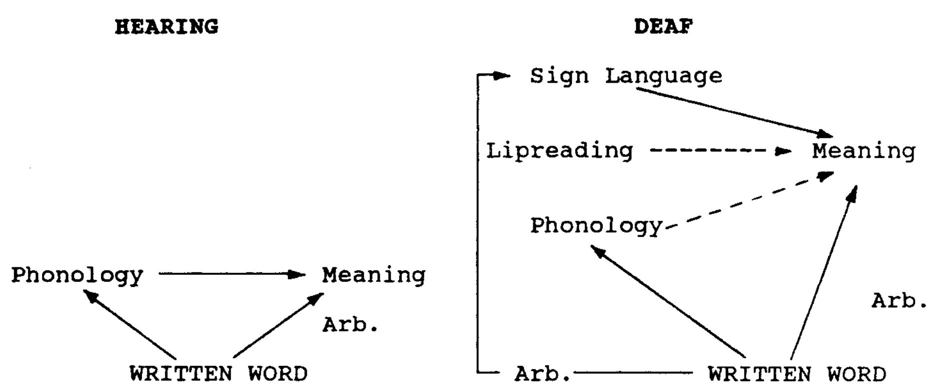

Figure 1 Schematic Representation of Different Paths to Meaning of the Written Word Used by the Hearing (left) and the Deaf (right).

Figure 1 represents schematically the links between phonetic representation, orthographic representation, and meaning in the case of deaf and hearing children. As we have said, the existence of an overlearned link between the phonological representation of a word and its meaning, in the hearing child, is an aid in establishing a new path to the meaning, starting from the written word. In the deaf child, the phonological codes do not typically furnish reliable access to the meaning. As a matter of fact, in his case the connections between these representations and their meanings are much less numerous and less clear than for the hearing. In order to engage the dynamic process of reading acquisition which involves phonological coding, it would be necessary to find a path to the lexicon which would be functionally equivalent to the phonological one. Such a system should, in the first place, permit the child to understand a linguistic message apart from reading. In the second place, the system should possess a structure such that its links with the orthography are not arbitrary.

A candidate that could be considered is sign language. This system of communication has the great merit of being highly efficient at the development of an authentic primary linguistic competence in the deaf child. Unfortunately, it is necessary to note that the connection between the orthographic representation of a word and the corresponding sign is totally arbitrary. Consequently, the signs cannot help the deaf child to identify written words encountered for the first time, and thus play the role of interface between the written word and its meaning.

A potentially important path to the lexicon, for the deaf child, is speechreading. The use of speechreading is not limited to the deaf, but intervenes also in the processing of speech by the hearing (Campbell, 1986). This path to the lexicon has the quality of being phonologically structured. However, it has the inconvenience of presenting a high level of ambiguity. A high percentage of phonologically different syllables are not discriminable in speech reading. In order to reduce the limitations imposed by this inconvenience, some researchers have conceived systems of assistance to speechreading whose goal is to eliminate the ambiguities inherent in it (Fant1972). The following section will be devoted to examination of one of these systems in terms of its connection with reading in the theoretical framework developed to this point.

Le Langage Parlé Completé (Cued Speech)

LPC (Langage Parlé Completé) is the French form of "Cued Speech", developed by Cornett (1967). The system utilizes eight hand configurations that are executed in five locations, near the mouth. The hand configurations permit the identification of the consonants from what is simultaneously seen on the mouth during speech, and the locations in which they are executed permit identification of the vowels from what is seen on the mouth at the same time. The central idea is that consonants not discriminable in speechreading: /p,b,m/, for example, are accompanied by different handshapes (configuration cues). The same principle governs the agreement between the places of execution (spatial cues) and the vowels.

Conversely, the same cue (configuration or location) represents a group of consonants or a group of vowels easily discriminable in the scheme of lipreading. For example, a single configuration (the full hand) indicates that the consonant produced is a member of the group /t,f,m/, and a single location (at the chin) indicates that the vowel is a member of the group /ɔ, u, ɛ/. Thus, a single action (a specific hand configuration executed in a specific location), when viewed in combination with what is seen on the mouth, gives all the information needed identify a specific CV syllable. Syllables having more complex structures: CCV, CVC, etc., require an additional cue for identification of the additional consonant. The choice of handshapes/locations is determined entirely by what the speaker says, with dialectal and contextual variations which he/she expresses. Cued Speech is a system which, in principle, carries no more ambiguity, than oral language.

A great number of questions can be raised concerning this system, such as: What are the limits from the point of view of speed of execution? Can one imagine that the linguistic development of a deaf person could proceed on this base? etc. Putting aside some anecdotal data available, we do not possess for the moment systematic studies bearing on these problems. The only point which has given rise to systematic experiments concerns the utilization of Cued Speech in speech perception. Nicholls & Ling (1982) gave to a group of 18 profoundly deaf youngsters, ages 9 years 2 months, to 16 years 9 months, the task of identifying isolated syllables and words in context (in this condition the subject had to identify the key word of a sentence, this word being always the last word of the sentence).

The authors compared the identification performance of the subjects specifically in a condition in which only speechreading was available, to another one in which the cues were added to the normal input available in speechreading. The results show that the addition of the cues produced substantial gains in comparison with the speechreading condition alone. The percentage of correct responses went from about 30% to more than 95%.

Périer, Charlier, Hage & Alegria (1985) examined the effectiveness of Cued Speech in its French version at the level of comprehension of sentences. Their subjects were profoundly deaf children, ages 5 to 14 years. They were exposed to a series of video-recorded sentences, presented with and without cues. The subjects responded by choosing among four drawings, one of which was appropriate for the sentence. As in the Nicholls & Ling experiment, the introduction of the cues enabled the subjects to make significant gains in comparison with the control condition. The parents of some of the subjects participating in the experiment had learned and used Cued Speech to communicate with them. These children frequented schools where Cued Speech was not used. It is interesting to note that the gain obtained by this group of children through addition of the cues were greater than that of children who practiced Cued Speech exclusively at school.

The results of Nicholls & Ling (1982) could suggest that the performance of the children attains, thanks to Cued Speech, a level approaching 100%. The work just described provokes a bit of reduction in the degree of optimism which the former might arouse. The experiment of Périer *et al* examined different levels of difficulty of the task. In the most difficult of the conditions, although the beneficial effect of Cued Speech was present and systematic, the average performance was far from perfect. Further, the absence of a ceiling effect in this experiment makes evident individual differences which suggest hypotheses for future research. The two studies cited converge, however, on a fundamental point, which is that the deaf children exploit in speech perception the linguistic data conveyed by Cued Speech.

The studies presented so far show that Cued Speech assists the acquisition of a receptive linguistic competence in the deaf child. It is reasonable to suppose that, thanks to this system, he is going to develop a large vocabulary which will facilitate reading. Further, the items which compose this vocabulary have a structure eminently phonologic, even if acoustic input has not contributed in an important degree to their acquisition. From this fact, the possibility appears that the child establishes a system of correspondences between the orthographic representations of words and the corresponding Cued Speech code representations.

As said above, the correspondence between the phonological representations the hearing child has, and the orthography play an essential role in the acquisition of reading. The question is now whether Cued Speech can play a similar role for the deaf child. The situation of the deaf child who encounters for the first time a written word which he knows he has learned through Cued Speech does approximate that of the hearing child. The deaf child is potentially able to identify the word without any help, through applying the rules of transformation from orthographic units into their Cued Speech representations, which he recognizes. The more-or-less complex operations of assembling the Cued Speech code should become more and more efficient with practice. Further, they will be less and less necessary to the extent that the child reaches a large vocabulary allowing direct access to the lexicon from the written word. To summarize, one can conceive that Cued Speech, because it is approximately congruent with the orthography, can play a role similar to that which the phonology assembly plays in the hearing child in the process of reading acquisition. The goal of the present experiment is to explore certain aspects of these speculations.

Experiment

Purpose

The question examined in this study is whether some deaf children educated in a school where Cued Speech is used in class, when they are placed before orthographic material show a tendency to translate orthographic material into Cued Speech. As stated previously, this tendency could be justified by the fact that the child does use the Cued Speech to advantage in speech reception, that is to say, for understanding an "oral" message.

Foundation of the Method

The experimental situation used for studying the problem is a lexical decision task involving "priming." The subject looks at the screen of a computer where series of pairs of items are presented to him in rapid succession. The second item of each pair, the target, is either a word or an orthographically acceptable pseudo-word. The task of the subject is to decide as rapidly as possible whether the target item is a word or not. The first item of each pair, the priming stimulus, does not require an explicit response from the subject. It has been shown in a large number of experiments that if the priming stimulus and the target item share some semantic connection, the decision about the target *word* vs *non-word* is more rapid than in the control situation, in which priming stimulus and target are semantically unrelated (Meyer & Schvanevelt, 1971). For example, the time of reaction to the item *butter* is shorter if it is preceded by *bread* than if it is preceded by *bath*. This result has been interpreted as suggesting that the first item, the priming stimulus, is treated passively by the system. Its processing leads to the identification of it as a word (if the priming stimulus is a word), which automatically activates its semantic neighbors. The processing of the target word will then be facilitated by the fact that lexical entry has been activated previously by the priming stimulus.

Some forms of priming other than semantic ones can be conceived. In this work, we intended to determine whether Cued Speech intervenes in the process of word identification by looking at priming based on Cued Speech. The reasoning is as follows. Suppose that the subject assembles a Cued Speech code from the written representation of a word, in order to identify it. This code will tend to activate lexical entries, identical or similar on a Cued Speech basis, to those of the target word. Thus, for example, if the written word "souvent" ([suvɑ̃], often) was translated into Cued Speech as part of its identification processing, one can hope that its Cued Speech "neighbors" would be likewise activated. The processing of a word such as "saison" ([sezɔ̃], season) should then be facilitated. The same reasoning can be applied to the processing of pseudo-words. That is because the system cannot know *a priori* if the item is a word or not. The initial stages of the processing, including the working out of a Cued Speech code, will be identical in both cases. Consequently, one can make the hypothesis that a pseudo-word (as the priming stimulus) will have the same facilitating effect a word has on items which share its Cued Speech structure.

Conditions and procedure

The experiment includes two series of trials. In the first one, the series "WORD", the items used as priming stimuli were all words. In the second, the series "PSEUDO-WORD", they were always pseudo-words. In each series the subject passed four blocks of 42 trials each. Of these, 57% led to the correct response "yes" (meaning word), and 43% to the response "no" (pseudo-word). Each trial consisted of the sequential presentation of a pair of items: the priming stimulus and the target. The trial began with the appearance of the priming stimulus for a duration of 500 msec, in the center of the screen. At the end of that time, it disappeared and was replaced, in the same place, by the target item. The subject's response produced the disappearance of the target item.

Table 1 Some Examples of Pairs of Items Used in the Experiment. In the series "WORD" the first item of each par was always a word. In the series "PSEUDO-WORD" it was always a pseudo-word.

Semantic	vache	cheval	**Orthographic**	tajis	tapis
	voiture	auto		arunme	armoire
	table	chaise		branule	branche
Cued speech	nouveau	bec	**Cued Speech**	vebausse	canard
	souvent	saison		louba	chaine
	jeux	pain		raudeux	sapin
Control	fruit	bain	**Control**	nessie	rame
	nuit	animal		ranlas	franc
	savon	chocolat		numis	hiver

In the series "WORD" there were three conditions defined by the connections between the priming stimulus and the target, when the latter was a word: Semantic, Cued Speech and Control. In the series "PSEUDO-WORD" the conditions were: Orthographic, Cued Speech and Control. In each case the conditions were equally probable, and they were distributed at random throughout the series of trials. In the Cued Speech conditions, the priming stimulus and the target were chosen so that they had exactly the same cues (though they were not actually presented to the subject with cues). In the Semantic condition the two items of the pair bore some semantic relation to each other. In the Orthographic condition the items of each pair shared at least 50% of the letters and the extreme letters were always identical. It is important to note that the levels of priming, for the orthographic and Cued Speech conditions, were comparable, since the cues constitute roughly half the information in the Cued Speech message, the other half being what is seen on the mouth. Table 1 gives some examples of items used in the different conditions.

Subjects

The subjects included 16 children, all hearing-impaired from birth. Two of them were severely hearing-impaired and the others profoundly deaf. Their ages varied between 9.4 years and 12.8 years (average, 11.5 years). The school where they pursued their studies had adopted Cued Speech as a means of communication four-and-one-half years earlier. Fourteen of the sixteen subjects practiced Cued Speech from its installation in the school, the two others for 1.6 and 0.6 years, respectively. They were all considered as good "cuers" by their teachers.

A control group of 16 children was evaluated. They were scholars in a regular instructional program. Their ages varied between 9.2 and 12.5 years (average, 10.5 years).

Results

Mean reaction times for the correct responses by subject and by condition have also been calculated. These results appear in Figure 2. The diagram shows the results obtained by the entire group of deaf subjects (n = 16) and by a reduced group (n = 11) whose number of errors was comparable to that of the hearing subjects. The results for the "WORD" series are on the left, and those for the "PSEUDO-WORD" series are on the right.

The mean percentage of errors for the deaf was 19.6%. For the hearing the corresponding value was 9.6%. Five of the 16 deaf subjects exceeded 30% errors. Under some conditions these subjects reached the neighborhood of 50% errors, that is to say, they responded at a chance level. For that reason, we decided to exclude those subjects from the analysis. Figure 2, however, recovers the averages of the entire group of deaf subjects, along with those of the selected group of 11. The general picture of the results is not modified by that selection. The percentage of errors of the 11 subjects retained was 12.3%. It does not differ [*text missing, Ed.*]

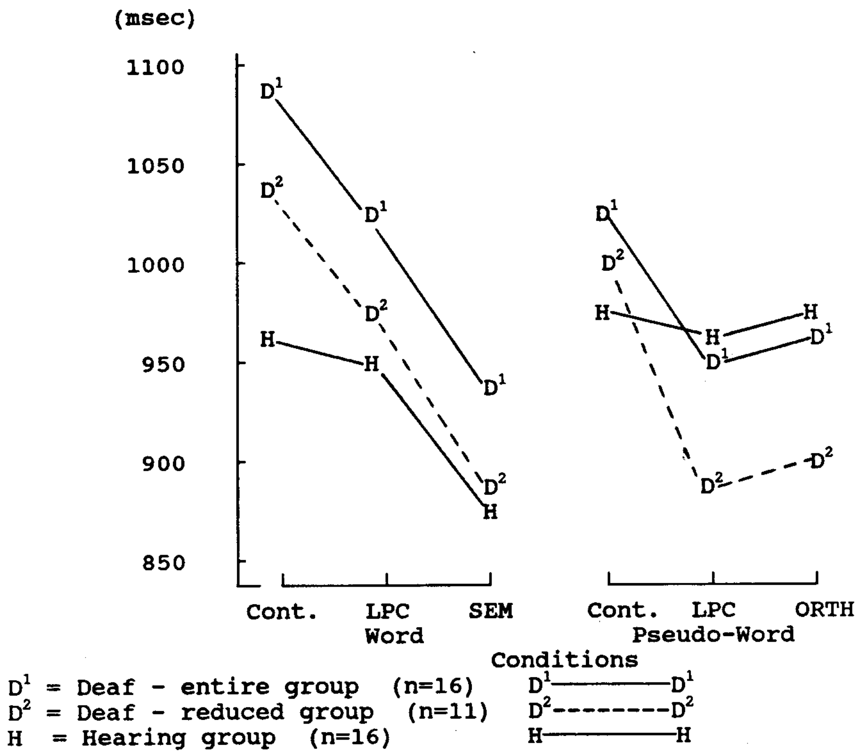

Figure 2 Mean Reaction Time (msec) as a Function of Condition for Each Group of Subjects

Figure 2 shows that the mean reaction time obtained in the Cued Speech conditions (with both series, WORD and PSEUDO-WORD) is more rapid than that in the corresponding control condition. The effect is also present in the hearing subjects, which could suggest that it is not a matter of an authentic effect of Cued Speech, but of a characteristic of the material used. It is, however, quantitatively more important in the deaf subjects than in the hearing subjects. An analysis of variance was carried out considering the factors Group (deaf and hearing), type of priming stimulus (words vs pseudo-words), Conditions and successive blocks (first to fourth). Only the results directly connected with the principal aim of the study will be explained in detailed fashion.

The factor Condition is highly significant ($F[3,75] = 80.06$; $p < .001$); but the factor Groups is not ($F<1$). This indicates that the two groups are globally similar from the point of view of reaction time. The interaction Group X Condition is significant ($F(3,75) = 8.49$; $p < .001$). As anticipated, the conditions affect differently the two groups of subjects. In order to test directly the effect of Cued Speech, the contrast Control Conditions--Conditions Cued Speech, obtained for the deaf, was compared with that of the hearing (without separating the results obtained with words and with pseudo-words as priming stimuli) by means of a t-test. The value attained a level of significance just acceptable ($t[25] = 1.75$; $p = .0462$, unilateral). The analysis by type of priming stimulus and by group shows that the contrast is never significant for the hearing ($t[10] = .44$ and .75, with words and pseudo-words, respectively), while for the deaf it is clearly significant in one of the two cases and marginally significant in the other ($t[10] = 1.58$ and 2.91; $p = .0726$ and .0078, respectively, with words and pseudo-words, test unilateral). The effect of semantic priming is present in the two groups of subjects $t(10) = 3.56$ and $t(15) = 3.28$; $p < .005$ for deaf and hearing, respectively.

The orthographic priming is present only for the deaf ($t[10] = 2.16$; $p < .05$). The comparison of the effect obtained by the two groups of subjects shows that it is significantly more important for the deaf than the hearing ($t[25] = 2.16$; $p < .05$). It is useful to point out that the orthographic condition, because of the fact that the two items of each pair share an important number of letters, approaches the Cued Speech condition. As a matter of fact, two items which are written in similar fashion are pronounced similarly also. Consequently, their Cued Speech representation. are correspondingly similar. For this reason it is possible that the effect observed in the orthographic condition in the deaf group is indeed a Cued Speech effect instead of a genuine orthographic effect.

Discussion

In the study we consider a potential source of difficulty of acquisition of reading in the deaf child, directly inspired by recent theories about reading acquisition in the hearing child. It has been proposed that the phonological representations of words the child has play an essential role in the process of acquisition. That is because the French orthography is *phonographic*. As a consequence it suffices to know the rules of translation which permit the assembling of a phonological code out of the written one, in order to be able to read words never seen before (or not seen sufficiently often to be able to identify them in a direct way). This ability permits the hearing child to be autonomous in reading, that is to say, to read without the help of another person, or of context. For the typical deaf child, the possibility of recognizing known words for which he does not possess a direct code of access is void, or very weak. The reason is that this child does not possess a "natural" phonological path giving access to his lexicon. Consequently, he cannot exploit the generative force of the alphabet. He is thus reduced to learning the meanings of the words "by heart."

We have considered that Cued Speech can play for the deaf child a role in reading acquisition similar to the one filled by the phonological representations in the acquisition of reading in hearing children. It possesses two qualities which make it a potentially interesting candidate. The first is that it has a structure based on the production of spoken words. Consequently, orthography represents Cued Speech as much as it represents spoken language. The second is that the children do understand a message produced in Cued Speech. This indicates that their internal lexicon is accessible through such a code. The child is able, at least in principle, to derive from the written form of a word a Cued Speech code contributing to its identification.

The possibility envisioned above is rather speculative. We had no empirical support suggesting that a deaf child would exploit Cued Speech in written word identification. To take the hearing child as a model, we know that for him, explicit understanding of the segmental structure of the spoken word, in connection with the comprehension of the alphabet principle, is not generally done in a spontaneous manner (Alegría & Morais, 1979), and depends to a great extent on the method of teaching reading to which the child is subjected (Alegría, Pignot & Morais, 1982; and Alegría, Morais & D'Alimonte, submitted). So, in the same way as the links between letters and groups of letters on the one hand, and segments of spoken words on the other, are not necessarily evident for the hearing child, the relationship between orthography and Cued Speech could remain out of reach for the deaf child.

The results of the experiment carried out suggest that deaf children attending a school where Cued Speech is practiced in class utilize it in reading. It is important to emphasize that the experimental situation considered in this study did not explicitly evoke Cued Speech. Consequently, it did not induce the subjects in any fashion to recode the sequences of letters in a code of that nature. For the child the task was to decide whether some series of items appearing on the screen were words or not. The effects of priming obtained suggest that the Cued Speech code which gives access to the lexicon has been internalized by the child.

It would seem that the system involved in the operation of written word identification requires the elaboration of Cued Speech codes without the subject having to make a deliberate or conscious effort. In connection with this, it is fitting to emphasize the fact that the duration of each priming stimulus was very short, 500 msec, after which it was replaced, without transition, by the target item. There is little likelihood that the explicit operations of working out a Cued Speech code would be responsible for the priming effects observed.

The experiment presented had an exploratory character. The principal goal was to establish the existence of effects of facilitation based on Cued Speech. We did not have, consequently, a precise hypothesis concerning differences between effects of priming obtained with words and pseudo-words. The results suggest that the effects are stronger in the second case than in the first. Other studies will be necessary in order to confirm and develop this result. The difference observed could suggest some differences in processing of lexical and non-lexical information.

The words utilized in the experiment were all frequent and well known to the children. It is probable that for such words the direct access to the lexicon was more rapid than the analytic procedures involving Cued Speech recoding. The presence of important effects of priming with the pseudo-words could come from the fact that the sequences of letters do not give rise to a direct identification. The procedures of transformation of the orthographic information into Cued Speech used in pseudo-word processing would have the occasion to manifest itself during the processing of the target item.

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