Effects of Literacy and Education on Measures of Word Fluency

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As part of a cross-national study of dementia epidemiology, two types of verbal
fluency tasks were administered to three groups of subjects, varying in level of
literacy and education, recruited from the rural district of Ballabgarh in northern
India. Subjects were asked to list items in a given semantic category (animals; fruits)
or words beginning with a given sound (the phonemes /p/ and /s/) the latter being
a minor modification of the more familiar initial letter fluency task in view of the
high prevalence of illiteracy in Ballabgarh. Analysis of variance revealed main ef-
fects of education and task with a task by education interaction such that education
had a greater effect on initial sound fluency than on category fluency. The results
are discussed in terms of their implication for the design of cross-cultural studies
and the evidence that the ability to segment speech into phonemic units is dependent
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INTRODUCTION

All verbal fluency tasks require the subject to produce as many words as
possible from a defined target set in a limited period of time but the nature
of the constraint defining the target set varies from task to task. In the most

direct descendants of Thurstone's (1938) original paradigm, the target set is defined by the initial letter of the word to be produced, although a spoken rather than written response is now usually required and the time is typically limited to 60 s (e.g., Benton and Hamsher, 1976; Benton, Hamsher, Varney, & Spreen, 1983; Borkowoski, Benton, & Spreen, 1967). On the other hand, several authors have studied verbal productivity in tasks where the response set is defined by a semantic category such as animals or foods (e.g., Goodglass & Kaplan, 1972; Newcombe, 1969).

However, verbal fluency is not a unitary phenomenon (Feyereisen, Pillon, & Partez, 1991) and there is good evidence that the two types of task are differentially sensitive to different disease states, presumably because of their demand on different cognitive processes that are, in turn, dependent on different brain mechanisms. Thus, initial letter fluency is particularly sensitive to frontal lobe dysfunction (Benton, 1968; Miceli, Caltagione, Gainotti, Masullo, & Silveri, 1981; Ramier & Hécaen, 1980), whereas category fluency appears to be relatively spared in frontal lesions (Coslett, Bowers, Verfaellie, & Heilman, 1991; Milner, 1975). By contrast, category but not initial letter fluency has been reported to be impaired in Parkinsons's disease (Auriacombe, Grossman, Carvell, Gollomp, Stern, & Hurtig, 1993; Beatty, Staton, Weir, Monson, & Whitaker, 1989; Matison, Mayhew, Rosen, & Fahn, 1982) and patients with Alzheimer's disease have been found to be more impaired on the former type of task (Butters, Granholm, Salmon, Grant, & Wolfe, 1987; Martin & Fedio, 1983; Monsch, Bondi, Butters, Salmon, Katzman, & Thal, 1992). These differences have been explained, though not entirely satisfactorily, by reference to the hypothesis that category fluency is affected by a deterioration in the structure of semantic knowledge which is said to characterize Alzheimer's disease (Butters et al., 1987; Martin & Fedio, 1983), whereas initial letter fluency places more demands on phonemic or lexical cues and the use of nonroutine search strategies which may be particularly difficult for patients with frontal lobe dysfunction (Butler, Rorsman, Hill, & Tuma, 1983).

Both types of verbal fluency task were included in the pilot version of a test battery that we designed for use in a survey of a largely illiterate and uneducated population in Ballabgarh in northern India as part of a cross-national study of dementia epidemiology. The tests, suitably translated and modified, were derived from those included in the cognitive screening battery used in the Monongahela Valley Independent Elders Survey (MoVIES) which has been described in detail elsewhere (Ganguli, Belle, Ratcliff, Seaberg, Huff, von der Porten, & Kuller, 1993). The intention was to devise a test battery for use in Ballabgarh that would be analogous to the MoVIES battery in that it tapped similar cognitive domains, using tests of similar relative difficulty that involved, where possible, similar task demands so that valid cross-national comparisons could be made (Chandra, Ganguli, Ratcliff,

Pandav, Sharma, Gilby, Belle, Ryan, Baker, Seaberg, DeKosky, & Nath, 1994).

The category fluency tasks from the MoVIES battery translated easily with minimal modification but, in view of the high degree of illiteracy in the Ballabgarh sample, the initial letter tasks were modified to require subjects to produce words beginning with a given phoneme (described to the subject as a given ''sound'' rather than a letter) and several examples were given. In spite of these modifications, the elderly, illiterate Ballabgarh subjects performed very poorly on the initial sounds task; 26% failed to produce any responses at all for either of two phonemes in a pilot study, and their mean total score for initial phonemes was less than 5, a rate of less than 2.5 words per minute.

This poor performance was puzzling at first. It did not seem to be attributable to failure to understand the requirement of a verbal fluency task *per se* as the Ballabgarh subjects performed well on fluency for animals and fruits. They also appeared to understand the concept of a similar sound as they seemed to be able to follow the examiner's examples of correct and incorrect responses when explaining the task, and they are known to appreciate rhymes. However, although initial letter fluency has not been studied in this regard, there are data to suggest that the ability to segment and manipulate speech sounds, particularly initial phonemes, depends on experience with an alphabetic writing system and that age, cognitive maturity, and auditory experience of a language rich in rhymes are not sufficient to develop it (Morais, Bertelson, Cary, & Alegria, 1986; Read, Yun-Fei, Hong-Yin, & Bao-Qing, 1986).

If this were the case one might expect that initial phoneme fluency, but not necessarily category fluency, would be particularly difficult for illiterate subjects without formal education whatever their facility with spoken language. In order to investigate this possibility and before finalizing the test battery for use in Ballabgarh, another sample of Hindi speaking subjects with varying levels of education and literacy were recruited and tested on both kinds of fluency task.

METHODS

Subjects

Subjects were recruited from the rural community of Ballabgarh, 22 miles from New Delhi, India, which is the intensive field practice site for the Center for Community Medicine of the All-India Institute of Medical Sciences in New Delhi. The language spoken is the Haryanvi dialect of Hindi, an Indo-European language written in Devanagiri script and pronounced phonetically. Because the great majority of the current elderly population we are studying is uneducated and illiterate, we selected three groups of 30 younger

volunteer subjects ages 34–55, stratified by education in order to investigate the effect of literacy on performance. All were judged to be cognitively normal and, specifically, nondemented by the examining neurologist. Thirty subjects had no formal education and were completely illiterate, 30 reported 5 years of education and were able to read a simple test paragraph in Hindi, and 30 had 10 years of education and were considered fully literate. The groups did not differ significantly in age (mean ages, respectively, 40.0, 38.3, and 39.3 years) or gender distribution (male to female ratio, respectively, 15 to 15, 16 to 14, and 17 to 13). All subjects continued to live in their home villages. Illiteracy is the norm rather than the exception in the region, particularly among women in this age group, and we are aware of no systematic difference between the groups other than the level of education and literacy by which they were stratified. In particular, we believe that our illiterate subjects were so because they were not exposed to reading instruction rather than because of low intelligence, learning disability, or other potential confounding factors.

Procedure

Testing was conducted at various sites in the subjects' village, typically in or outside the house of the village leader or at a neighborhood Health Center, by a neurologist (V.C.), general physician (R.P.), or neuropsychologist (S.S.) fluent in Hindi and familiar with the district. Category fluency instructions were translated to Hindi and slightly modified but essentially identical to the conventional American instructions used in the MoVIES tasks. Thus, subjects were asked to ''tell me all the animals (fruits) you can think of'' in 60 s. Initial phoneme fluency was assessed for the phonemes /p/ and /s/, both of which are common initial phonemes in Hindi as well as in English. The names given to the letters representing these phonemes in Hindi are equivalent to the sounds they represent but instructions for the fluency task consistently referred to the sounds involved without invoking the concept of graphemic representation. Thus, subjects were asked to say all the words they could think of beginning with the sound in question which was modeled by the examiner with the conventional restriction that proper nouns, numbers, and multiple forms of the same root word were not permitted. These instructions were supplemented by examples using the phoneme /l/ and 60 s was allowed per trial. The category task was always administered before the sounds task and scores for individual categories and individual phonemes were each combined to yield an overall category score and an overall initial phoneme score.

RESULTS

Table 1 shows the scores on each type of fluency task broken down by level of education. Scores were subjected to a 2 (type of fluency task) × 3

TABLE 1
Verbal Fluency Scores by Educational Level

	0 Ed ($n = 30$)	5 Yrs ed ($n = 30$)	10 Yrs ed ($n = 30$)
Categories			
Mean	21.07	23.53	26.77
(SD)	(4.80)	(5.66)	(4.86)
Initial phonemes			
Mean	4.77	12.4	23.13
(SD)	(4.79)	(6.15)	(5.96)

(educational level) repeated measures (task) ANOVA. This revealed a significant main effect of task ($F(1, 87) = 257.19$, $p < .0001$) and level of education ($F(2, 87) = 55.40$, $p < .0001$) with category scores being higher than initial phoneme scores and higher levels of education being associated with better performance. However, there was also a significant interaction between education level and type of task ($F(2, 87) = 32.43$, $p < .0001$) attributable to a greater effect of education on the initial phoneme task.

DISCUSSION

Why should education affect initial phoneme performance more than category performance? Even the uneducated, illiterate subjects performed adequately on the category task with scores approximating the level that one would expect based on Western norms, indicating that their difficulty with initial phonemes was not attributable to any overall reduction in fluency or general cultural differences affecting test taking behavior. While one might suppose that some individuals with deficits, such as poor spelling, associated with lack of education may be handicapped in initial letter fluency tasks, we were careful to present the task in terms of initial *sounds* rather than the letters representing them. In any event, we are not aware of compelling evidence for a substantially greater effect of education on initial letter fluency than on other cognitive tasks (including category fluency), although variability at lower educational levels tends to be wide (Lezak, 1983).

The most likely explanation in our view is that, in this population, educational level is a marker for literacy and that literacy is the crucial factor. There is abundant evidence of a link between phonological awareness and reading ability, most of it documenting the importance of phonological ability as a precursor and predictor of reading ability (Bentin, 1992; Bradley, 1989). The connection appears to be causal (Blachman, 1991) and explicit training in phonological skills is an integral part of some reading training programs (e.g., Lindamood and Lindamood, 1975).

However, there is also evidence of an inverse causal connection in that experience with alphabetic writing has been shown to facilitate the segmenta-

tion of speech sounds. This effect has not previously been studied with the verbal fluency paradigm but the phenomenon has been demonstrated in tasks where subjects must add or delete the initial consonant of an utterance spoken by the examiner (Morais, Cary, Alegria, & Bertelson, 1989) and tasks in which subjects must simply report whether a target consonant was spoken (Morais et al., 1986). In both cases, literacy in an alphabetic writing system is required for successful performance, whereas this is not required for rhyme detection or segmentation of musical sounds (Morais et al., 1986) and literacy in a nonalphabetic Chinese writing system is not sufficient for the initial consonant task (Read et al., 1986).

Most recently, Ben-Dror, Frost, and Bentin (1995) have shown that the manner in which orthography represents phonology affects skilled readers' awareness of the phonological structure of their spoken language. They showed in a well controlled study that Hebrew speakers who were asked to delete the first sound of a spoken word tended to delete the initial consonant–vowel segment more frequently than English speakers. The Hebrew speakers were also significantly slower than English speakers in deleting initial phonemes but faster in deleting initial syllables. The authors plausibily attributed these effects to the fact that in Hebrew, unlike English, alphabetic units mostly represent consonant–vowel units, thereby presumably fostering awareness of segments of that size.

We did not embark on this study with the primary purpose of testing the hypothesis linking speech sound segmentation with experience of alphabetic writing. Rather, we came to the hypothesis as a post hoc explanation for the association between literacy and initial phoneme fluency that we observed in our Indian subjects. Nevertheless, the present results suggest that initial phoneme fluency may be added to the list of tasks known to be sensitive to this effect. As a corollary, neuropsychologists may need to consider another factor when attempting to explain the selective impairment of initial letter fluency in patients with cerebral lesions, namely an impaired ability to segment speech sounds, though this is admittedly likely to be less prevalent among patients with frontal lesions than the executive deficits previously advanced as an explanation for the effect of frontal lesions on these tasks.

On a more practical level, these results emphasize the need to be careful when designing test batteries for use in different settings or interpreting results obtained with different subject groups. This is particularly important given the recent increase of interest in cross-cultural studies (Brayne, 1993; Zhang, Katzman, Salmon, Jin, Cai, Wang, Qu, Grant, Yu, Levy, Klauber, & Liu, 1990). Not all tasks which purport to measure a given cognitive function (e.g., ''verbal fluency,'' ''attention'') are equivalent and the factors limiting performance on a given task may be quite different in different populations. Cross-national comparisons involving tasks and populations for which this is true, like initial phoneme fluency in Ballabgarh and the Monogahela Valley, are not susceptible to any simple interpretation and test batteries de-

signed for use in such studies need to be prepared with this problem in mind. Accordingly, initial phoneme fluency has been deleted from the test battery to be used in our studies in Ballabgarh.

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