Using Working Memory Measures to Assess Language Learning in South African School Beginners from Diverse Socioeconomic and Linguistic Backgrounds

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Abstract

This paper proposes that verbal working memory measures may be more appropriate measures of language learning than vocabulary tests for school beginners from diverse socioeconomic and linguistic backgrounds. Participants were 120 school beginners, divided into high and low socioeconomic groups, with equal numbers of English first- and second-language speakers in each group. All were being educated in English. Expectedly, the high socioeconomic group performed significantly better on the vocabulary tests relative to the low socioeconomic group, while there were no significant differences between the socioeconomic groups on all except one of the four working memory tests. While socioeconomic status (living standards, caregiver level of education and parental employment) accounted for much of the variability in the vocabulary scores, it only explained very small amounts of variability in the children's performance on the verbal working memory measures. This suggests that the working memory measures were less influenced by the children's socioeconomic status. Thus, working memory assessments appear to be less influenced by socioeconomic factors and may constitute fairer forms of evaluating language learning for children from differing socioeconomic and linguistic backgrounds.

Introduction

The appropriate and fair assessment of children from diverse socio-economic and linguistic backgrounds is a challenge. Valid assessment of language learning is fundamental in evaluating children's educational progress and determining whether support is required. Language learning is generally evaluated with vocabulary tests. Such tests tap long-term learning and verbal exposure from the social environment, and are closely linked to socioeconomic status (SES) [1]. They cannot distinguish typical from atypical language development in school-beginners from poorer, non-Western environments whose backgrounds limited their exposure to words and concepts [2]. These difficulties are compounded when the test is not in the L1. Thus, it is necessary to consider alternative, fairer evaluations of language functioning. Verbal working memory tests may be less sensitive to SES influences than vocabulary tests, and may provide a fairer indication of language learning for children from low SES and linguistically diverse backgrounds.

Working memory is related to fluid intelligence and is fundamental to learning [3]. It immediately stores and processes information, inhibits irrelevant information, and performs sequences of mental actions necessary for the achievement of goals. In the Baddeley and Hitch (1974) model, working memory comprises inter-related mechanisms, of which two are domain specific short-term stores (verbal and visuo-spatial) and two are domain general mechanisms (the central executive and episodic buffer). The short-term stores are the phonological loop (briefly retains verbal material), and the visuospatial sketchpad (temporarily stores visual and spatial information). The central executive co-ordinates the functioning of these stores. The episodic buffer integrates information from the stores and long-term memory into unified, meaningful episodes [4].

Working memory tests evaluate the above mentioned components. Despite their theoretical distinctness, no task is a pure measure of any component, but would tap these to varying extents [5]. In this study, the focus was on phonological loop and central executive functioning. The phonological loop is related to vocabulary learning, and comprises a phonological store, which briefly retains information in a phonological code, and a rehearsal process, which refreshes and maintains representations in the phonological store. Thus, the loop immediately stores new phonological forms of words as a basis for learning and storing phonological structures of a language. Thus, the capacity of the phonological loop indicates word learning ability [6]. The central executive plays a more general role in learning, and supports the development of reading skills [7], numeracy, mathematics [8] and language comprehension [9]. The stimuli in working memory tests are selected to be equally unfamiliar to all testees, or utilise material that is not explicitly taught (patterns/designs), or is very well

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learned (digits/letters). Consequently, such tests, which focus on processing, rather than knowledge-based cognition, are less likely to disadvantage children with differing prior knowledge and experience than vocabulary tests, and may provide a purer indication of language learning [10].
There is evidence both for and against the influence of SES on working memory [11; 12]. This may be due to differences in working memory measures and sample ages in these studies. Chronic stress from continued exposure to poverty negatively impacts working memory. This effect becomes apparent later, in adulthood [13], and may explain the differential findings between child and adult samples. The unresolved relationship between working memory and SES, and the importance of accurate assessment of children's verbal abilities provided the rationale for this study. The hypothesis was that SES would exert less influence on verbal working memory tests in comparison to vocabulary tests.

Methods

Participants

There were 120 Grade 1s (62 boys; 58 girls), 59 from high SES backgrounds, 61 from low SES circumstances. The low SES group attended government schools in a working class area, while the high SES children attended government and private schools in an affluent area. Within the high SES group, 29 spoke English at home (EL1), while 30 spoke an African language at home and English was their second language (EL2). Within the low SES group, 37 were EL1 and 24 were EL2. All attended English-medium schools.

Measures

These were the Ravens Coloured Progressive Matrices (RCPM; nonverbal intelligence [14], the British Picture Vocabulary Scale (second edition) (BPVS-II; receptive vocabulary [15], the Automated Working Memory Assessment (AWMA; verbal working memory [16] and the Living Standards Measure (SES) [17]. Caregivers of the high SES group possessed significantly higher levels of education (t= 21.59; p=.0001; d=3.96), professional status (t=25.56; p=.0001; d=4.65) and SES (t=15.28; p=.0001; d=2.79).

Procedure

Children were assessed individually, in a single session. Ethical issues were appropriately addressed.

Results and Discussion

Table 1. Descriptive statistics by SES group

	High SES (N= 59)			**Low SES (N= 61)**			**Significance Tests**		
	M	**SD**	**Range**	**M**	**SD**	**Range**	***F***	***p***	***d***
Age (yrs)	6.86	.43	6-8	6.61	.76	6-8	5.17	.024	.40
BNT	26.75	11.08	9-45	12.54	4.39	6-25	53.13	0.0001	1.67
BPVS	66.56	16.19	33-94	38.92	10.30	18-64	85.65	0.0001	2.04
Ravens (IQ)	20.78	5.61	8-31	16.51	3.55	10-28	25.03	.00002	.91
Verbal Simple Span									
Nonword Recall	16.29	4.16	5-26	12.51	4.86	2-21	10.68	0.001	.84
Digit Recall	24.90	5.02	15-38	21.41	4.12	10-31	4.27	.041	.76
Verbal Complex Span									
Counting Recall	12.25	3.35	7-21	10.69	3.26	4-21	0.042	0.839	.47
Backwards Digit Recall	8.81	2.48	3-15	7.18	2.89	0-13	1.24	0.267	.53

Note: $p < .02$ for vocabulary measures; $p < .01$ for working memory measures (Bonferroni corrections for two and four tests respectively); IQ and age were covariates.
The high SES group performed significantly better on both vocabulary tests (BPVS, BNT), and outperformed the low SES group on Nonword Recall, a verbal span measure. Home language and SES accounted for considerable variance in the vocabulary measures (61% in BPVS; 57% in BNT), with SES contributing the majority (52% and 42% respectively). Socioeconomic status explained smaller amounts of variance in the processing-dependent relative to the storage dependent working

memory tests (Processing-dependent: 15% in Nonword Recall, 13% in Digit Recall; Storage-dependent: 5% in Counting Recall, 7% in Backward Digit Recall). Home language contributed 4% of variance in Backward Digit Recall, 9% in receptive vocabulary and 15% in expressive vocabulary. Thus, verbal working memory measures appear to be less influenced by SES background than vocabulary tests. Tests that tap verbal working memory processing and draw less on long-term knowledge appear to be least resilient to SES disadvantage. However, this sample was young and may not yet have experienced a continuous effect of socioeconomic handicap, unlike older samples where SES adversely impacted working memory [18].

One measure of working memory, Nonword Recall, was slightly affected by SES, contrary to previous findings [2; 6]. The inclusion of EL2 children in the sample may have been an influence, as previous studies administered this test in the L1. This suggests that vocabulary knowledge in long-term memory influences the learning of new words (or nonwords). Analogies may be drawn with known words during Nonword Recall, accounting for the influence of SES, and the better performance of the high SES group (which had significantly better vocabulary abilities) on this test.

The results show that vocabulary ability, which is driven by educational opportunity, is affected by SES, while three working memory tests appear unaffected by such influences. These tests may provide a fairer and more realistic picture of a child's verbal learning ability. Processing-dependent working memory measures offer a fairer way to distinguish between children whose poor performance reflects fundamental language processing deficits and children whose poor performance stems from differing experiential backgrounds. This finding is useful, given attempts to find equitable cognitive assessments for children from diverse home and language backgrounds, such as South Africa, where inequitable social conditions may have impacted on children's cognitive ability, giving unfair advantage to those who have been raised in situations of privilege, and serving to reinforce inequalities.

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