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Commentary

Persistent Difference in Short-Term Memory Span Between Sign and Speech

Implications for Cross-Linguistic Comparisons

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Short-term memory (STM) is thought to be limited in capacity to about 7 ± 2 items for linguistic materials and 4 ± 1 items for visuospatial information (Baddeley & Logie, 1999; Cowan, 2001). Recently, we (Boutla, Supalla, Newport, & Bavelier, 2004) challenged this dichotomy between linguistic and visuospatial STM by showing that STM capacity in users of American Sign Language (ASL) is also limited to about 4 or 5 items. This finding suggests that although longer spans appear for speech, spans are not necessarily longer for linguistic materials across all modalities. Wilson and Emmorey (2006) responded that because we evaluated span using digits for English speakers and letters for ASL signers, the difference we reported might have stemmed from stimulus selection rather than language modality. Here we address this claim by reporting an experiment in which we reexamined STM span in English speakers using letters and compared the outcome with results we and Wilson and Emmorey have obtained for ASL signers.

It is important to note that the discrepancy between our previous results and those of Wilson and Emmorey is not in the obtained span in signers—found by all parties to be around 4 to 5 items (Fig. 1a). Rather, Wilson and Emmorey disputed whether the digit span of 7 ± 2 in speakers is an appropriate benchmark for comparison with signers. Using letters to measure span in speakers, they found a span of only 5.3, comparable to that of signers. They suggested that there is no difference in span between the two languages. Here we show that their result is not due to their use of letters instead of digits. Rather, in selecting letters that are translations of one another in English and ASL, Wilson and Emmorey failed to control the stimuli in each language for phonological factors known to affect span size.

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One such crucial factor is phonological similarity. The finding that span is longer for digits than for letters in English speakers is not new (Cavanaugh, 1972). However, this difference has been attributed to the greater phonological similarity of letter names than digit names in English (Conrad & Hull, 1964; Mueller, Seymour, Kieras, & Meyer, 2003). In our previous study, we used letters with signers and digits with speakers to match stimuli in this important regard. Finger-spelled letters are less phonologically similar than number signs in ASL and therefore are more comparable to digits in English speakers. To demonstrate that there is nothing special about letters versus digits, other than the fact that many letter names are highly similar in English (e.g., *bee*, *dee*, *ee*, *gee*) and thus prone to produce shorter spans, we show here that when phonologically controlled letter materials are used with English speakers, the span of speakers returns to the typical 7 ± 2 range and continues to contrast with the span of signers.

EXPERIMENT

As in our previous study and Wilson and Emmorey's, we measured span size using procedures from the Wechsler Adult Intelligence Scale (WAIS). Twenty monolingual native English speakers viewed video clips of a person speaking sequences of items at a rate of one item per second and were asked to recall each sequence in order of presentation. Sequences increased in length from two to nine letters, with two sequences at each length, until the participant failed on both sequences of the same length. Two correlated measures were obtained: (a) span, the longest list length recalled correctly, and (b) WAIS score, the score obtained by awarding 1 point for each correct sequence. Three different types of stimuli were tested: (a) English letters chosen to be phonologically dissimilar (*M*, *Y*, *S*, *L*, *R*, *K*, *H*, *G*, or

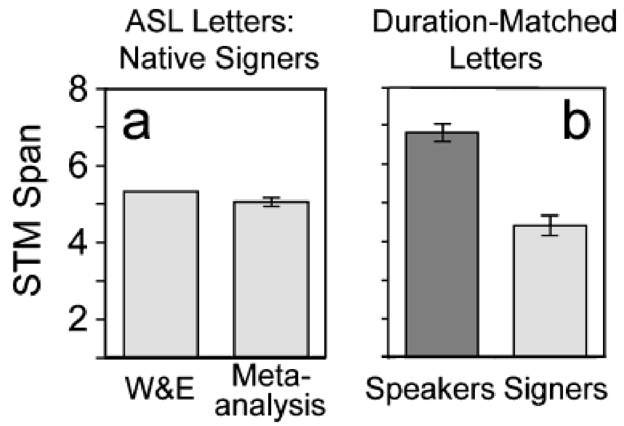

Fig. 1. Short-term memory (STM) span in speakers and signers. The graph in (a) shows that the STM span Wilson and Emmorey (2006; W&E) found for signers is not different from the span we have previously documented in signers (meta-analysis of signer span computed from 136 observations in 63 native signers). The graph in (b) compares letter STM span for speakers in the present study with that for signers when letters were matched for phonological factors across languages.

P[1]); (b) the letters used by Wilson and Emmorey (*B*, *V*, *F*, *S*, *X*, *L*, *R*, *K*, *H*), which have more phonological overlap; and (c) the standard digit span stimuli (1–9). Phonological similarity and other phonological factors were controlled for by measuring articulation duration for each type of stimuli with a list-reading technique (Mueller et al., 2003).

As expected, the letters used by Wilson and Emmorey produced shorter spans than digits did ($M = 5.6$ vs. $M = 7.0$), $t(19) = 6.47$, $p_{rep} = .99$, $d = 1.06$, and also took longer to enunciate ($M = 2.57$ vs. $M = 3.11$ items/s), $t(19) = 6.27$, $p_{rep} = .99$, $d = 1.03$. More important, the phonologically dissimilar letters produced a faster articulation rate than Wilson and Emmorey's letters ($M = 2.82$ vs. $M = 2.57$ items/s), $t(19) = 4.96$, $p_{rep} = .99$, $d = .57$, as well as a greater span ($M = 6.8$ vs. $M = 5.6$), $t(19) = 3.71$, $p_{rep} = .99$, $d = 0.97$. The dissimilar letters led to a span comparable to that for digits ($M = 6.8$ vs. $M = 7.0$), highlighting the importance of controlling for articulatory duration in span measurements. The same pattern of effects was observed for WAIS scores (*M*s = 8.2, 10.3, and 10.8 for Wilson and Emmorey's letters, our phonologically dissimilar letters, and digits, respectively, for English speakers). When we compared speakers' span for dissimilar letters with signers' span for letters with a comparable rate of articulation in ASL (from our previous study), the span of signers remained shorter than that of speakers ($M = 4.4$ vs. $M = 6.8$), $t(30) = 3.41$, $p_{rep} = .99$, $d = 1.97$ (Fig. 1b).

[1]*G* and *P* appeared in the same list only at list length 9. There are not enough English letters with no phonological overlap to build controlled lists of nine items, but with these nine letters and the restricted use of *G* and *P* together, the lists at all lengths had minimal overlap.

DISCUSSION

In our previous study, we compared span for ASL letters in signers with span for digits in speakers for several important reasons. Signers are highly practiced at chunking letters (in finger spelling), and ASL letters are phonologically simple and can be chosen to have minimal phonological overlap. We have shown here that when these same criteria are used to choose English letters, the letter span in speakers remains higher than that in signers. The important point is not to match stimuli according to whether they are letters or numbers, but rather to match stimuli on functional characteristics known to affect STM span. In using the same letters for ASL signers and English speakers, Wilson and Emmorey did not ensure equivalent phonological properties of materials across languages. When we did this, we found that finger-spelled letters still produced a lower span in signers than similarly controlled letters or digits produced in speakers. Consistent with this view, a meta-analysis of several studies of serial span in signers in our laboratory indicated a mean of 5 ± 1 items (Fig. 1a).

There are circumstances under which the STM span for English speakers can be reduced to four or five items, but this should not obscure the well-documented fact that for English speakers, there are many conditions in which STM span equals seven. The surprising finding remains that the span of signers is well below that of speakers even under conditions known to maximize span, such as when the ASL stimuli are phonologically dissimilar, short, fast to enunciate, and highly familiar. It is important to note that this difference is limited to serial spans; as Experiment 3 of our previous study (Boutla et al., 2004) shows, signers and speakers display comparable working memory capacity when the task does not require serial recall. As we stated in that study, we believe the difference in serial span between signers and speakers arises from a difference between the auditory and visual modalities in temporal-order encoding, but this generalization must be tested in future research. At present, however, we can reassert that the serial spans for English and ASL are different even when they are measured using letters, as long as articulatory duration is matched across languages.

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