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[ Lay Language Paper Index | Press Room ]

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## Absolute Pitch Is Associated with a Large Auditory Digit Span: A Clue to Its Genesis

Diana Deutsch ddeutsch@ucsd.edu
Kevin Dooley
Department of Psychology
University of California, San Diego
La Jolla, CA 92093

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The genesis of absolute pitch – the ability to name or produce a note of particular pitch in the absence of a reference note – has long been the subject of speculation (Ward, 1999). The ability is very rare in North America and Europe, where its prevalence is estimated as less than one in 10,000 (Takeuchi and Hulse, 1993). Its prevalence is strongly associated with early onset of musical training, and is much higher among speakers of tone languages such as Mandarin, who would have learned to associate pitches with verbal labels very early in life (Deutsch et al, 2004, 2006, 2009). However, among speakers of nontone languages such as English, the large majority of those with early and extensive musical training do not acquire this ability. The question then arises of why a few individuals who speak nontone language acquire absolute pitch, while most others with equivalent age-of-onset and duration of musical training do not do so. Here we show that a group of absolute pitch possessors displayed an unusually large auditory digit span compared with a group of nonpossessors who were matched for age, and for age-of-onset and duration of musical training. The enhanced memory for spoken words found here could facilitate the development of associations between pitches and their spoken labels early in life, and so lead to the acquisition of absolute pitch.

All subjects were tested individually, and were given an auditory digit span test, followed by a visual digit span test. In both tests, a string of digits was presented on each trial, and the subject attempted to repeat the digits back verbally in the order in which they had occurred. The first two trials consisted of strings of six digits; the next two of strings of seven digits; the next two of strings of eight digits; and so on. The test was ended when the subject made an error on both trials containing the same number of digits, and the subject's score was taken as the largest number of digits that he or she had repeated back correctly at least once. In both tests the digits were presented at a rate of 1/sec. For the auditory test, the subject listened to the digits through headphones, and for the visual test the digits were presented successively at the center of a computer screen.

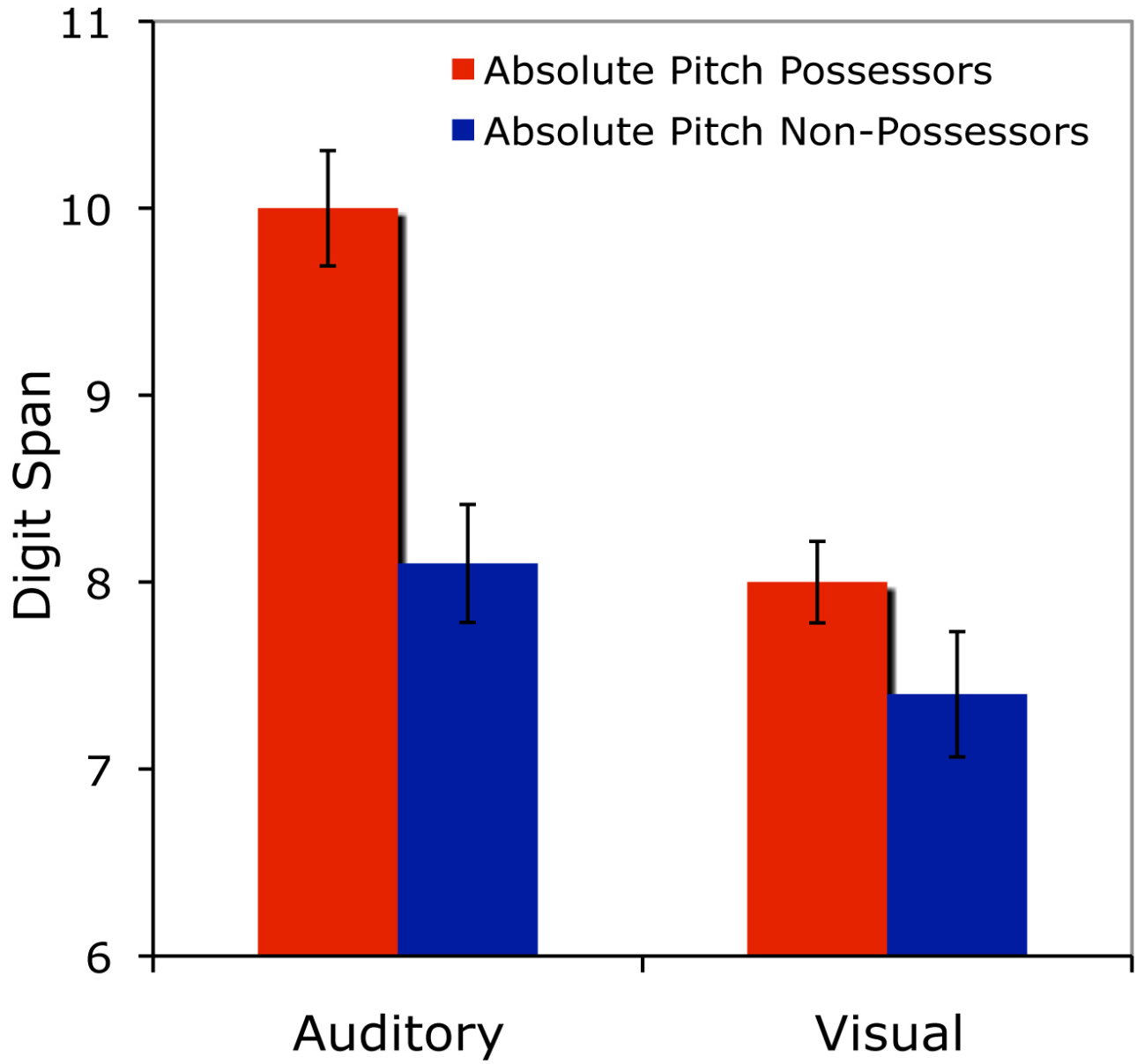


*Figure 1. Average scores on the auditory and visual digit span tests, produced by absolute pitch possessors and by nonpossessors, with the two groups matched for age, and for age-of-onset and duration of musical training.*

Figure 1 shows the average scores on the auditory and visual digit span tests produced by the two groups of subjects. We can see that for the auditory test, the absolute pitch possessors substantially outperformed the nonpossessors: The average digit span for the absolute pitch possessors was 10.0, while it was 8.1 for the nonpossessors. This difference between the two groups was highly significant statistically. In contrast, for the visual test, the two groups exhibited very similar performance, and their scores were not significantly different from each other. Our finding therefore shows that absolute pitch is associated with an unusually large memory span for speech sounds, which in turn could facilitate the development of associations between pitches and their spoken labels early in life. Interestingly, since the absolute pitch possessors and nonpossessors did not differ statistically on the visual digit span test, the advantage to the possessors was confined to the presentation of sounds.

Speakers of tone language were not included as subjects in this experiment, since it has been conjectured that such persons would have acquired the neural circuitry underlying absolute pitch early in life, during the

period in which they acquired other features of speech (Deutsch et al., 2004), so that an explanation of absolute pitch possession involving a large auditory memory span for speech sounds would for them be redundant. For the same reason, speakers of pitch accent languages were not included. However, it is possible that absolute pitch possessors who speak a tone or pitch accent language might also have a large memory span for spoken words. We also conjecture that this unusually large memory for speech sounds might have a genetic basis. Since absolute pitch possession is dependent on early musical training, we conjecture that family members of absolute pitch possessors who have not had early and extensive musical training might also have large auditory digit spans. At all events, this paper reports the first finding of an association between absolute pitch and an unusually large memory span for speech sounds, so providing a clue to its genesis.

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[ Lay Language Papers Index | Press Room ]