Does novel music improve verbal memory in individuals with Williams syndrome?

Research Thesis

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by

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Abstract

Williams syndrome (WS) is a genetic disorder characterized by intellectual delay and an affinity for music. It has been shown that familiar music can enhance verbal memory in individuals with WS who have had musical training. There is evidence that unfamiliar, or novel, music may also improve cognitive recall. Therefore, this experiment was designed to examine if a novel melody could also enhance verbal memory in individuals with WS, and to better evaluate musical enjoyment and music training in this population. We presented spoken or sung sentences that described an animal and its group name to individuals with WS, and then tested their immediate and delayed memory using both multiple choice and recall formats. Parents reported that their children enjoyed music much more than their peers (mean = 4.38 on a 0-5 Likert scale). Across all participants, mean scores were higher for the sung vs. spoken stimuli, but not to a significant degree. When we analyzed those who had formal music training (n = 23) and those who did not (n=21), results showed a significant main effect for group in the delayed recall category. Those with formal music training did significantly better on delayed recall in the sung condition (mean = 1.70, SD = 1.33) than those without formal music training (mean = 0.86, SD = 1.06); [$F(1,42) = 4.786$, $p = .034$]. Music therapy, age, and Verbal IQ did not impact performance for the sung stimuli. These findings suggest that individuals with WS who participate in formal music lessons may have enhanced long-term verbal memory of sung stimuli using a novel melody.

Introduction

Williams syndrome is a neurodevelopmental disorder characterized by a deletion of 26-28 genes on chromosome 7q11.23, with a prevalence of 1 in 7,500 births (Stromme, Bjornstad, & Ramstad, 2002). Individuals with Williams syndrome have mild to moderate cognitive delays, with an average IQ of 55 (Martens, Wilson, & Reutens, 2008). Research findings indicate that individuals with WS have relatively strong verbal skills, but have a significant weakness in visuospatial abilities (Mervis & Klein-Tasman, 2000). Language studies in individuals with WS show a typical (but delayed) development of language in aspects such as verbal comprehension and mean length utterance, while other studies show atypical language development in areas of phonological processing and morphology (Martens et al., 2008).

Individuals with WS also have impairments in their short and long-term memory (Sampaio, Sousa, Férnandez, Henriques, & Goncalves, 2008). Sampaio et al. (2008) sought to confirm that individuals with WS suffer from impairments in multiple memory systems by analyzing short versus long-term memory, as well as verbal and visuo-spatial working memory components. Their results revealed that working memory components, such as phonological loop and visuo-spatial sketchpad, are impaired, and that both short and long-term memory is equally affected in individuals with WS (Sampaio et al., 2008). Memory systems such as the phonological loop and the visuospatial sketchpad are working memory components that are involved in short term working memory (Jarrold, Baddeley, & Hewes, 1999). The phonological loop maintains auditory and visual information, while the visuospatial sketchpad is designed to store and process visual and spatial information (Baddeley, 1992; Rosenquist, Conners, & Roskos-Ewoldsen, 2003).

In contrast to their memory deficits, research studies have demonstrated that individuals with WS are highly drawn to music in terms of enjoyment and emotional reaction (Don, Schellenberg, & Rourke, 1999). In addition, musical ability is common in individuals with WS in such areas as sense of pitch, rhythm and melodies, and they also show a high sensitivity and over responsiveness to sound (Hopyan, Dennis, Weksberg, & Cytrynbaum, 2001). Some individuals with WS also have intense interest in certain sounds and can recognize the make and model of cars and vacuum cleaners just by the sounds that they make (Levitin et al., 2004).

There is evidence that music enhances verbal memory in typical individuals. Text that is sung is more accurately recalled than text that is spoken in a rhythmic tone (Wallace, 1994). While there is evidence that familiar music may enhance recall of text (Chazin & Neuschatz, 1990; Purnell-Webb & Speelman, 2008; Wallace, 1994), other studies suggest that unfamiliar music is beneficial in aiding verbal memory (McElhinney & Annett, 1996; Yalch, 1991).

Yalch (1991) found that novel music jingles helped consumers recall advertisements in ad campaigns. For this study, ads were presented with or without music and varied memory tasks were used. For half of the participants, an aided recall task was used in which participants were presented with slogans and asked to provide the brand that used the slogan. A recognition task (multiple-choice test) was used for the other half of the participants, with each slogan presented with a choice of five possible brands. The musical jingle enhanced memory better for the recall task than for the recognition task, suggesting that a novel melody may be useful in aiding memory when individuals have few retrieval cues.

McElhinney and Annett (1996) evaluated recall of song lyrics in either a spoken or sung condition using a non-familiar melody. The participants listened to the lyrics three times, and were asked to freely recall as much as they could after each presentation. The results showed that the number of words recalled between each trial increased significantly for the participants in the sung condition, giving further evidence that an unfamiliar melody can be beneficial in aiding recall of verbal information.

It is believed that music training has many advantages to learning as opposed to other learning strategies, due to the fact that music makes learning more enjoyable for people of all ages (Chan, Ho, & Cheung, 1998). Chan et al. (1998) assessed verbal memory and found that individuals with musical training learned significantly more words than those individuals without musical training. Research also suggests that musical lessons may help improve one's ability to increase memory for information presented in a musical fashion. Ginsborg and Sloboda (2007) found that individuals with high levels of musical expertise (either college music students, and/or professional singers), had better recall of both words and melody to an unfamiliar song than individuals who had less or no musical expertise. Musical training also requires little to no verbal skills, therefore individuals with cognitive and language impairments are easily able to engage in musical activities and can benefit from learning strategies involving music (Chan et al., 1998).

Recent research examined how music could enhance verbal memory in individuals with WS (Martens, Jungers, & Steele, 2011). A memory task of spoken or sung sentences that described an animal and its group name was used in two experiments, with the sung sentences presented to the familiar tune of "Twinkle, Twinkle, Little Star."

Findings revealed that only the participants who had participated in formal music lessons scored significantly better on the verbal memory task when the sentences were sung rather than spoken. Those who did not have formal music lessons showed no benefit for either the sung or spoken conditions. The current experiment expands the previous experiment implemented by Martens, Jungers & Steele (2011), by examining whether unfamiliar music affects verbal memory, as well as whether a background of musical lessons impacts performance in either condition.

This experiment measured short- and long-term memory for eight animal group names that were taught in either a sung or spoken condition. Data was also collected regarding the participants' level of musical interest, type of musical interest, specific musical background, presence of musical abilities, and experience with formal music lessons. It was predicted that using a novel melody would benefit the participants' memory for the sung stimuli regardless of participation in formal music lessons, but those who had participated in formal music lessons would have higher verbal memory scores than those who had not participated in formal music lessons.

METHODS

Participants

Forty-six participants with WS (28 females, 18 males) ranging in age from 8-48 years of age (mean age = 22.11 years) participated in this study. Most participants participated in the study at the 2012 Williams Syndrome Conference in Boston, with a few participants recruited in the area at a local Williams syndrome event. All participants were administered the Kaufman Brief Intelligence Test, 2nd edition (Kaufman &

Kaufman, 2004) and the average Verbal IQ was 75.71 (SD = 10.39), Nonverbal IQ was 73.96 (SD = 18.38), and Composite IQ was 71.76 (SD = 13.30).

Music Questionnaire

The parents/caretakers of the participants completed a music questionnaire that was designed for this study in order to assess the participants' level of musical interest, type of musical interest, specific musical background, presence of musical abilities, and whether they had taken any type of formal music lessons (see Appendix A). There were eight questions that assessed musical interest. The first two questions assessed the participants' enjoyment of music compared to their siblings and their peers using a Likert scale. The next six questions assessed the participants' emotional reactions to music or specific songs, preferred style or type of music, and particular likes/dislikes. The following eight questions assessed the participants' musical background, with two questions assessing how often the participants listened to music as a baby and between the ages of 1 to 5 compared to their siblings. Two questions assessed how often participants were sung to as a baby, and how often they currently listen to music and what type of music they listen to. The remaining four questions assessed whether the participant had been involved in formal music lessons, music therapy, or sung in choir. The last three questions of the music questionnaire assessed the participants' musical ability in an open-ended format.

Design and Procedure

The participants were first shown a picture of each animal and they had to correctly identify the animal by its name. As in the previous study, the participants were shown pictures of each animal group (either sung or spoken) and told the group name that corresponded to the picture. All sentences followed the format "A group of ____ is called a ____." See Table 1 below for a complete list of all of the sentences. The participants heard eight sentences, repeated twelve times, teaching them the animal group name that corresponded to each picture. There were four stimulus sets, each with four spoken and four sung sentences. Each stimulus set was randomized for order of stimuli and order of sung and spoken sentences.

Table 1
List of eight animals and sentences of animal group names.

Turtle	A group of turtles is called a bale
Duck	A group of ducks is called a raft
Giraffe	A group of giraffes is called a corps
Pig	A group of pigs is called a drove
Horse	A group of horses is called a band
Camel	A group of camels is called a train
Bear	A group of bears is called a sloth
Tiger	A group of tigers is called a streak

The spoken and sung sentences were recorded to an unfamiliar tune instead of the familiar tune of "Twinkle, Twinkle" that was used in the previous study. A novel melody was created for this study that included the same harmonic and rhythmic structure as "Twinkle, Twinkle Little Star" (See Appendix B).

The participants' memory for the stimuli was assessed using immediate recall, and then immediate multiple choice, directly following the listening task. For the immediate recall questions, participants were simply asked, "A group of ____ is called a

what?" For the immediate multiple choice questions, participants were asked, "Is a group of ____called a ____, a ____, or a ____?" The participants then completed a computerized distracter task in which they decided whether certain faces were friendly or not. This distracter task took approximately 15 minutes. The participants' memory for the animal group names was again assessed using recall and multiple-choice formats.

Data Analysis

Paired samples *t*-tests were used to compare the participants' scores on the memory tests for the sung and spoken conditions. An analysis of variance was performed to evaluate the effect of condition on the memory scores for those who had and had not participated in formal music lessons. The effect of age, IQ, and other types of musical experience on memory scores was examined using Pearson correlation coefficients.

Results

Results of Music Questionnaire

Thirty-eight (38) parents reported how often their child listened to music daily, with 66% of the children listening to music for 2 or more hours per day (30 min. - 8 hours). Fourteen (14) of the participants had participated in music therapy, and twenty-five (25) of the participants had participated in choir. According to parental ratings, 56.5% of the WS participants enjoyed music significantly more than their peers (mean = 4.38 on a 0-5 Likert scale), and 43.5% of children enjoyed music significantly more than their siblings (mean = 4.12 on a 0-5 Likert scale).

Just over half of the participants had taken formal music lessons (n = 24). This includes playing any type of instrument or taking voice lessons for over one year. Of those who had taken formal music lessons for over one year, parents reported that 66.7% played piano, 12.5% had voice lessons, 8.3% played the drums, 8.3% played the violin, and 4.2% played the guitar.

Sung vs. spoken condition

We examined the memory scores for all participants on each of the four test formats: immediate recall and immediate multiple choice, delayed recall and delayed multiple choice. Across all participants, the mean scores for the combined test formats (immediate and delayed, recall and multiple choice) were higher for the sung (mean = 8.07, SD = 4.33) vs. spoken (mean = 7.36, SD = 3.97) stimuli, but not to a significant degree (See Table 2 for scores for each format). Length of participation in music therapy, length of participation in choir, age, and Verbal IQ did not impact performance on the sung stimuli ($p > .05$). Participants reported heightened enjoyment of music significantly more than their peers and siblings, as well as longer lengths of time listening to music per day, but neither of these had an effect on their memory scores for the sung stimuli ($p > .05$). Overall, there was no significant interaction between condition (sung vs. spoken) and whether or not the participants had taken formal music lessons. However, those who participated in formal music lessons did significantly better on delayed recall in the sung condition (mean = 1.70, SD = 1.33) than those who had not participated in formal music lessons (mean = 0.86, SD = 1.06); [$F(1,42) = 4.786$, $p = .034$], showing a main effect for formal music lessons.

Table 2
Memory scores for all participants across all test formats.

		Mean Spoken (*SD*)	Mean Sung (*SD*)	*t*	*p*
N=45	Immediate Recall	1.11 (0.96)	1.42 (1.16)	-1.55	0.13
	Immediate Multiple-Choice	2.36 (1.28)	2.60 (1.41)	-1.06	0.30
N=44	Delayed Recall	1.18 (1.24)	1.30 (1.27)	-0.59	0.56
	Delayed Multiple-Choice	2.68 (1.18)	2.68 (1.27)	0.00	1.00

There was no correlation between scores on the delayed recall sung condition and how much the participants enjoyed music compared to their siblings (Pearson r = -.107, p = .512) or their peers (Pearson r = -.033, p = .832). Similarly, scores on the delayed recall sung condition were not associated with how often the participants listened to music when they were children (Pearson r = -.083, p = .604), their heightened emotional reaction to music (Pearson r = .124, p = .423), or the number of hours the participants listen to music per day (Pearson r = .037, p = .824). When these correlations were conducted separately for those who had and had not participated in formal music lessons, similar non-significant findings were found.

Discussion

The results of this study show that individuals who participated in formal music lessons, such as playing a musical instrument or taking voice lessons for over one year, scored significantly better on the delayed recall task when stimuli were sung than when they were spoken, compared to those who had not taken formal music lessons. These

findings were evident regardless of other musical experience, age, or Verbal IQ. These results support the findings of the previous experiment implemented by Martens, Jungers, & Steel (2011), that individuals with WS who participated in formal music lessons performed better on the sung stimuli than those who did not participate in formal music lessons.

The current results show that those who participated in formal music lessons had better recall of the sung stimuli in what could arguably be considered the most difficult task (delayed recall), which support the findings of Yalch (1991), who found that music is beneficial in aiding memory when individuals have few retrieval cues. The finding that recall was aided for the stimuli presented in the sung condition, but not the spoken condition, supports previous evidence that recall is more fluent when words are presented with a melody (Ginsborg et al., 2007).

The results of the current study show that an unfamiliar melody can be beneficial in aiding verbal recall. This evidence supports previous research indicating a greater recall of words in a sung verses spoken condition using an unfamiliar melody (McElhinney & Annett, 1996; Yalch, 1991). The current finding that the participants' scores were higher for the sung verses spoken stimuli also supports previous evidence that retention is greater when lyrics are sung verses spoken (Bottari & Evans, 1982; Yalch, 1991).

The results of the music questionnaire revealed that a vast majority of participants reported heightened enjoyment of music and length of time listening to music per day, but this had no effect on their learning or their memory scores in the sung condition. The findings that the participants with WS had a heightened enjoyment and overall emotional

response to music support previous findings in the WS literature (Don et al., 1999; Hopyan et al., 2001).

Participation in formal music lessons may have an impact on the neurological pathways that are involved in processing and retaining verbal information. Previous research has shown that music may enhance verbal memory by temporally sequencing verbal information to the rhythm of the melody during learning (Thaut, Peterson, & McIntosh, 2005). The individuals with WS who participated in formal music lessons may have performed better because their previous musical experiences led to changes in their neural processing, giving them an advantage on the musical stimuli.

Future studies may examine the type of formal music lesson that is most beneficial in aiding memory, and how researchers can implement their findings to benefit educational outcomes in individuals with WS. More research can be done on the specific benefits of taking formal music lessons, such as what age is most beneficial to start lessons to insure an advantage of aiding memory. Once research narrows down the best age to begin lessons and what type of lesson or instrument is most beneficial, researchers can begin to work on the best ways of presenting academic information in a fashion that can benefit learning for individuals with WS. Researchers may even find that formal music lessons may benefit verbal memory in individuals with other types of developmental disorders.

References

Baddeley, A. (1992). Working memory. *Science, 255,* 556-559.

Bottari, S. S., & Evans, J. R. (1982). Effects of musical context, type of vocal presentation, and time on the verbal retention abilities of visual-spatially oriented and verbally oriented learning disabled children. *Journal of School Psychology, 20*(4), 329-338.

Chan, A. S., Ho, Y.-C., Cheung, M.-C. (1998). Music training improves verbal memory. *Nature, 396*, 128.

Chazin, S., & Neuschatz, J. S. (1990). Using a mnemonic to aid in the recall of unfamiliar information. *Perceptual and Motor Skills, 71*, 1067-1071.

Don, A. J., Schellenberg, E. G., & Rourke, B. P. (1999). Music and language skills of children with Williams syndrome. *Child Neuropsychology, 5*(3), 154-170.

Ginsborg, J., & Sloboda, J. A. (2007). Singers' recall for the words and melody of a new, unaccompanied song. *Psychology of Music, 35*(3), 421-440.

Hopyan, T., Dennis, M., Weksberg, R., & Cytrynbaum, C. (2001). Music skills and the expressive interpretation of music in children with Williams-Beuren syndrome: Pitch, rhythm, melodic imagery, phrasing, and musical affect. *Child Neuropsychology, 7*(1), 42-53.

Jarrold, C., Baddeley, A. D., & Hewes, A. K. (1998). Genetically dissociated components of working memory: evidence from Down's and Williams syndrome. *Neuropsychologia, 37*, 637-651.

Kaufman, A.S., & Kaufman, N.L. (2004). *Kaufman brief intelligence test* (2nd ed.). Circle Pines: American Guidance Services.

Levitin, D. J., Cole, K., Chiles, M., Lai, Z., Lincoln, A., & Bellugi, U. (2004). Characterizing the musical phenotypes in individuals with Williams syndrome. *Child Neuropsychology, 10*(4), 223-247.

Martens, M. A., Jungers, M. K., & Steele, A. L. (2011). Effect of musical experience on

verbal memory in Williams syndrome: Evidence from a novel word learning task. *Neuropsychologia, 49*, 3093-3102.

Martens, M. A., Wilson, S. J., & Reutens, D. C. (2008). Research review: Williams syndrome: A critical review of the cognitive, behavioral, and neuroanatomical phenotype. *The Journal of Child Psychology and Psychiatry, 49*(6), 576-608.

McElhinney, M., & Annett, J. M. (1996). Pattern of efficacy of a musical mnemonic on recall of familiar works over several presentations. *Perceptual and Motor Skills, 82*, 395-400.

Mervis, C.B., & Klein-Tasman, B.P. (2000). Williams syndrome: Cognition, personality, and adaptive behavior. *Mental Retardation and Developmental Disabilities Research Reviews, 6*, 148-158.

Purnell-Webb, S., & Speelman, C. (2008). Effects of music on memory for text. *Perceptual and Motor Skills*, *106*, 927-957.

Rosenquist, C., Conners, F. A., & Roskos-Ewoldsen, B. (2003). Phonological and visuospatial working memory in individuals with intellectual disability. *American Journal on Mental Retardation, 108*(6), 403-414.

Sampaio, A., Sousa, N., Férnandez, M., Henriques, M., & Gonclaves, Ó. (2008). Memory abilities in Williams syndrome: Dissociation or developmental delay hypothesis? *Brain and Cognition, 66*, 290-297.

Stromme, P., Bjornstad, P. G., & Ramstad, K. (2002). Prevalence estimation of Williams syndrome. *Journal of Child Neurology, 17*(4), 269-271.

Thaut, M. H., Peterson, D. A., & McIntosh, G. C. (2005). Temporal entrainment of cognitive functions: Musical memories induce brain plasticity and oscillatory synchrony in neural networks underlying memory. *Annals of the New York Academy of Sciences, 1060*, 243-254.

Wallace, W. T. (1994). Memory for music: Effect of melody on recall of text. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*(6), 1471-

1485.

Yalch, R. F. (1991). Memory in a jingle jungle: Music as a mnemonic device in communicating advertising slogans. *Journal of Applied Psychology 76*(2), 268-275.

Appendix A

Music Questionnaire

NAME: _____DATE OF BIRTH: _____

Please answer the following questions about your child by checking the appropriate response. Thank you for your time!

Musical Interest:

1. How much does your child appear to enjoy music compared to his/her **siblings**?

____Significantly ____A Little ____About the ____A Little ____Significantly
Less Less Same More More

2. How much does your child appear to enjoy music compared to his/her **peers**?

____Significantly ____A Little ____About the ____A Little ____Significantly
Less Less Same More More

3. Does your child emotionally react to certain songs or types of music?

____No unusual reaction ____Cries or appears sad ____Becomes happy or overly excited

4. If your child cries when he/she hears certain songs, please list the songs that bring about this response:

_____ _____

_____ _____

_____ _____

5. Does your child specifically prefer one style or type of music? If they enjoy more than one style, please number their preferences (1, 2, 3, etc.).

____Country ____Classical ____Instrumental ____Hip-Hop

____Rap ____Rock ____Alternative ____Blues

____Other (specify)_____

6. Please list any particular style/type of music that your child dislikes.

_____ _____

_____ _____

_____ _____

7. If your child becomes happy or overly excited when he/she hears certain songs, please list the songs that bring about this response:

_____ _____

_____ _____

_____ _____

8. Please list any other emotional reactions that your child may have in response to music:

_____

Musical Background:

9. How often did your child listen to music as a baby (1st year)?

____Less than siblings ____Same as siblings ____More than siblings

10. How often did your child listen to music between the ages of 1 to 5?

____Less than siblings ____Same as siblings ____More than siblings

11. How often did someone sing to your child when they were a baby?

____Never ____Rarely ____Occasionally ____Often ____Everyday

12. How many hours of the day does your child listen to music? _____

What type of music do they listen to? _____

13. Has your child ever had formal music lessons? ___No ___Yes

If yes,

- What instrument (e.g. piano, guitar, drums, etc.) or voice?

  _____
- Age lessons began: _____
- Frequency and duration of lessons (e.g. once a week for 30 minutes):

  _____
- How long did they take the lessons? (Number of months or years):

  _____

14.Was your child involved in music therapy? ___No ___Yes

If yes,

- Age music therapy began: _____
- Frequency and duration of therapy (e.g. once a week for 30 minutes):

  _____
- How long did they have music therapy? (Number of months or years):

  _____

15. Has your child sung in a choir? (School or religious organization)

___No ___Yes

If yes,

- Age they began choir: _____
- Frequency and duration of choir (e.g. once a week for 30 minutes):

  _____
- How long did they participate in choir? (Number of months or years):

  _____

16. If your child plays an instrument or sings, how many hours of the day do they play or sing?

(Not including lessons) _____

Musical Ability:

17. Does your child seem to display any particular musical abilities?

_____

_____

_____

18. Any other comments you wish to add regarding your child's musical interests or abilities?

_____

_____

_____

19. Does your child appear to be particularly sensitive to any other types of sounds?

_____

_____

_____

If so, has this sensitivity changed since childhood? _____

Thank you!!!

Appendix B