Mozart Sharpens and Mahler Degrades the Word Memory Trace

Christiane Lange-Küttner1, Stella Rohloff1

1 School of Social Sciences, Psychology, London Metropolitan University

Keywords: mood, emotion, mozart effect, word memory, memory delay

We investigated the impact of the Mozart effect on word memory when music was heard in the delay rather than using music to induce mood or as background music. A sample of N = 84 participants was randomly assigned to one of three groups listening to a one-minute sound clip of Mozart (Kleine Nachtmusik) or Mahler (Adagietto) during the delay, with a third control group waiting in silence for the word memory test. Words were positive, negative or neutral and matched for word length and frequency. The word memory task was repeated three times (enforced rehearsal). Word memory was best after Mozart and worst after Mahler, with memory performance in the control condition in between. The Mozart effect occurred for word memory across positive, negative and neutral words. The Mozart effect also occurred independently of ethnicity, or the level of happiness in the participants. We conclude that word memory traces sharpened after Mozart’s music because the sonogram and spectrograms showed that this music had self-contained and bounded phrases like in psycholinguistic structures of words and sentences. In contrast, word memory traces may have washed out and degraded during the delay because Mahler’s music was flowing like a foreign language speech stream where a native speaker would not be able to parse words.

A one-page article in Nature in 1993 showed that listeners to ten minutes of Mozart’s music had a comparably increased score in an IQ test thereafter. This result was coined as the Mozart effect and had a large impact in the public domain and as well in the scientific community (Rauscher et al., 1995). Many follow-up studies mention that newborn babies in the US state Georgia received a Mozart tape from the government and reported similar policy decisions (Nantais & Schellenberg, 1999). The original study was followed-up in more than 60 peer-reviewed articles over the years, more than for any other Nature article (Bangerter & Heath, 2004) and publications are still appearing (Talero-Gutiérrez & Saade-Lemus, 2018). The Mozart effect was researched and debated in developmental psychology with particular emphasis on the difference in effects of music listening vs. music making (Ivanov & Geake, 2003; McKelvie & Low, 2002; Rauscher & Hinton, 2006; Waterhouse, 2006a, 2006b). It could be demonstrated that long-term listening to Mozart for six months decreased epilepsy in children, with the exceptions of those who had epileptic discharges in the occipital, visual area in the brain (Brackney & Brooks, 2018; Lin et al., 2011).

In short, the Mozart effect consists of elevated spatial and abstract performance and an increased non-verbal IQ score after having listened to Mozart’s sonata for two pianos in D major in comparison to (1) relaxation instructions on tape, and (2) silence (Rauscher et al., 1995). In studies with adults, the emphasis of the debate was about the question whether arousal (Jones et al., 2006; Jones & Estell, 2007), or preference (Nantais & Schellenberg, 1999; Thompson et al., 2001), or mood (Steele et al., 1999) were responsible for the IQ performance improvement. Recently, the original hypothesis that Mozart music would have a distinct effect on brain waves (Rauscher et al., 1995) was confirmed by an independent research group who found an increase in the index of alpha band rhythm activity (a pattern of brain wave activity linked to memory, cognition and an open mind for problem solving) in adults over the life-span but not in those with mild cognitive impairment (learning difficulties) (Verrusio et al., 2015).

In the current study, we investigated whether a Mozart effect could be observed when remembering positive, negative and neutral words. Music lessons appear to improve word memory although Mozart in particular was not tested (Holden, 2003). Music lessons can improve memory in many ways, for instance, by improving fine motor skills as a result of learning to transform musical notations into fluid finger movements (Lange-Küttner & Finn, 2008). Mozart also improved reading fluency in children (Yen-Ning et al., 2017). A comparison of Mozart, Vivaldi and Glass during a verbal memory task showed no significant effect on different age groups of adults, but a positive effect of Vivaldi’s (but not Mozart’s) music on verbal fluency could be observed in younger adults (Giannouli et al., 2019). Another problem is that the Mozart effect, or any other effect of uplifting music, is dependent on whether divided attention is necessary as with background music, or whether the music itself is associated with particular words as in music lyrics (Ferreri & Verga, 2016). While the background music can increase the cognitive load, musical associations may facilitate binding...
processes which can help memory. In the current study, we are not increasing participants’ cognitive load by using music as a background as overall it does not seem to be helpful for verbal memory (Nguyen & Grahn, 2017). Instead, a short music clip is played in the delay between word presentation and word recognition phase of the memory experiment. Because verbal memory is improved by rehearsal (Lange-Küttner et al., 2017; Lange-Küttner & Sykorova, 2015), we used the same word lists in three repetitions. In this way, we could not only test whether memory performance as such would be improved, but also whether the music in the delay would have an effect on verbal learning.

We compared the enchanting music of Wolfgang Amadeus Mozart’s Kleine Nachtmusik (Smith & Joyce, 2004) with the calming music Gustav Mahler’s Adagietto in the delay phase as in previous research both were confirmed to have positive vs. negative (depressive) mood induction powers (Storbeck & Clore, 2005). Mozart’s Kleine Nachtmusik is also called Serenade No. 13 for strings in G major. The composition Adagietto by Mahler is also known as Symphony No. 5 and is mostly played in C minor. The hypothesis was because low arousal music can enhance verbal memory (Nguyen & Grahn, 2017), that in the verbal domain, the Mahler music clip may compete with the Mozart effect. In a third control condition, the delay was unfilled and participants just waited for the verbal memory test.

METHOD

PARTICIPANTS

G*Power (version 3.1.9.4) analysis (Faul et al., 2007), with an effect size of .25, an alpha level of .05 and power of .95, showed that to test the main group effect of the Mozart effect in the music delay, a sample of N = 87 needed to be tested. A sample of N = 87 was tested, however, in the analysis phase, boxplots showed three participants’ data sets with random responses resulting in pronounced negative D’ values for accuracy. The analysis was thus conducted with N = 84 participants (56 females, 28 males) between the age of 19 and 65 (M = 32 years, SD = 11 years). Each experimental group had 28 participants, with 19 women in the Mozart group, 16 women in the Mahler group and 21 women in the silent control group. The sample consisted of 55.6% (n = 45) participants identifying as White, 17.9% (n = 15) Black, 17.9% (n = 15) Asian, 3.6% (n = 3) Mixed and 7.1% (n = 6) Other. All participants lived in London, UK. They were fluent English speakers, had no hearing problems, and none of them received compensation for attending this study. Because we tested European music which may be less familiar for participants from cultures of other continents, we split the sample into a white sample (n = 45) and an ethnic minority sample (n = 39).

APPARATUS AND MATERIAL

The experimental program SuperLab 5.0 was used to program the memory task. The task was tested on a Toshiba laptop with a 15” screen. Thirty target words of various length were presented in a randomized sequence in the middle of the screen for 750 ms with 500 ms interstimulus interval, on a white background, in Arial small letters, font size 20. The thirty target (and the thirty distracter) words were selected from the British National Corpus (Leech et al., 2014), with word frequencies either above 150 or below 50. There were three word categories, positive, negative and neutral. Word length in terms of letters and syllables were matched between targets and distracters as much as possible, see Table A1.

After the presentation, an exactly one-minute long music sound file was played. The Mozart 1-minute sound clip was produced from the Serenade No. 15 in G-Major, K.52. The Mahler 1-minute sound clip was produced from the Symphony No. 5, Adagietto. The sampling rate of both music clips was 44100 Hz. Figure 1 shows the sonograms and the spectrograms of the Mozart and the Mahler sound files (Adobe Audition). Because the list with thirty words was quite long, we kept the delay with the music limited to one minute. Participants repeated the entire memory task two times, so they would hear the music clip three minutes in total. Figure 1 shows that the Mahler music was quieter and with less distinguishable phrases which produced a more continuous flow of music than the Mozart piece, see the upper sonogram in decibel (db). Participants were provided with headphones and were able to adjust the volume to create individually comfortable hearing of the music. The Mahler music was also of lower frequency throughout, see the lower sound spectrogram with the scale in Hertz (Hz).

In the test phase, participants saw all thirty target and distracter words of Table A1 in a randomized sequence. Words were presented until the participants pressed the response button (self-paced) without a maximum time limit.

The Happiness Scale. We used the happiness scale of Lyubomirsky and Lepper (1999) to measure mood. It consists of four questions and has been used with young adults as well as in retirement communities. The test has a high retest reliability of Pearson’s r > .85 after a month. In the current study, happiness is measured with a 7-point Likert-scale. One item is reversed. The first question requires participants to rate themselves as being in general not a very happy person (1) to being a very happy person (7). The second question tests relative happiness in comparison to peers. The third question assesses the resilience of happiness in the face of adversity. The fourth was the reversed question asking about depression. The happiness questions were also presented on a white screen with centered black letters in Arial 20. Participants pressed the respective number key on the keyboard as a response. Response times were self-paced.

PROCEDURE

The study was approved by the departmental Ethics committee. Participants were briefed and debriefed via the computer-based program. The instructions were ‘We are investigating if there is a connection between mood and memory. Therefore, a short questionnaire, audio files or silence and some words will be presented in a computer-based program. You will experience three repeated memory tests. The study is anonymous and takes about 15 minutes. The collected data will be securely stored to maintain privacy, and the data will be destroyed after ten years. Press any key to continue.’ This was followed by informed consent on screen by pressing the key ‘C’. Participants were not able to continue the experiment if they did not give their consent.

This was followed by personal questions about their gender, age in years, ethnicity, English language fluency, and whether they had hearing problems. Only participants who agreed that they were fluent English speakers and had no hearing problems were able to continue the experiment. Thereafter, they answered the four questions about their happiness on a scale of 1-7. This short questionnaire was followed by the memory task.

The instruction for the memory task was ‘Please look at a sequence of words and try to remember each word as best as you can.’ The instruction for the two music conditions was the same: ’Now you will listen to music for 1 minute.’ The
instruction for the control condition was ‘Now you will have 1 minute of silence.’ In the memory recognition phase, the instruction was to press the key ‘C’ if they remembered the words, or to press the key ‘M’ if they did not. It was necessary to press a key to continue. When all sixty words were judged, participants were informed that the task would be repeated. The experiment ended in debriefing the participant.

**Data generation.** Accuracy data were corrected by deducting false positives, that is, participants had responded that they had seen a word when in fact they did not. This protected against a yes-bias in participants’ responses (Macmillan & Creelman, 2005).

**RESULTS**

**Happiness.** One-way ANOVA with happiness as the dependent variable showed that there was no significant difference in happiness between the three experimental groups (Mozart $M = 5.03$, Mahler $M = 4.75$, Silence $M = 5.04$), $F(2, 84) = .76, p = .573$. The same model with ethnicity (white $M$
Mozart Sharpenes and Mahler Degrades the Word Memory Trace

We were interested in the question whether we could obtain the Mozart effect when presenting just a brief 1-minute delay between the word presentation and word recognition phase. Overall, each participant heard three minutes delay between the word presentation and word recognition (first block: $M = 1404$ ms, second block: $M = 1192$ ms, third block: $M = 1114$ ms). Post-hoc pairwise comparisons (Bonferroni-corrected, one-tailed) showed the first repetition was the most efficient in increasing speed, $MD = -212.42$, $p < .001$, CI 95% [-280.37, -144.47] compared to the difference between the second and third task repetition $MD = -77.95$, $p = .032$, CI 95% [-159.54, 33.53].

**DISCUSSION**

We were interested in the question whether we could obtain the Mozart effect when presenting just a brief 1-minute delay between the word presentation and word recognition phase. Overall, each participant heard three minutes delay time music. We could confirm the hypothesis that Mozart music improves word memory in comparison to music of Mahler, but not in comparison to a control condition of just silence. The Mozart effect did occur for word memory across positive, negative and neutral words. The Mozart effect also did occur independently of ethnicity, or the level of happiness in the participants. We neither used the music to induce mood (Storbeck & Clore, 2005), nor as background music to the task which would have increased cognitive load (Ferreri & Verga, 2016). Instead we tested whether Mozart’s or Mahler’s music in the memory test delay would improve or degrade the memory traces of the presentation words. We could find both effects, improvement of word memory traces after Mozart and degradation of word memory traces after Mahler.

Contrary to previous accounts that have focused on arousal (Jones et al., 2006; Jones & Estell, 2007), preference (Nattais & Schellenberg, 1999; Thompson et al., 2001), mood (Steele et al., 1999) and enjoyment (Lim & Park, 2018) as explanations for the Mozart effect, we would like to offer another account which derives from psycholinguistic research (Toukhsati & Rickard, 2012). We acknowledge that such organismic factors clearly offer a psychophysiological account of the Mozart effect (Verrusio et al., 2015). However, the actual cognitive mechanism of the Mozart effect may have its roots in language processing (Scott, 2005). The sonograms of the Mozart and Mahler clearly showed that the *Kleine Nachtmusik* has more diverse phrases, while the *Adagietto* consists of a very flowing music which is similar to the flow of language that one does not understand like at the beginning of life, or when hearing a foreign language. Young children need to learn to bootstrap words from the language flow (Friedrich & Friederici, 2008; Nazzi & Houston, 2006) which then are combined into phrases (Friederici & Oberecker, 2008). Thus, in short, the clearly delineated phrase structure in the Mozart music may have supported the word memory trace, while the flowing stream of the Mahler music would have washed up word boundaries in the memory trace like the edges of visual object shapes in a watercolour drawing. This could be called ‘tone painting’ (Patel, 2008, p. 520) although what is usually meant with this concept is the imitation of meaningful sounds such as environmental or animal sounds.

What is meant here is that a phrase has a contour in the way that we parse words or sentences from the speech stream, and this can be achieved in various ways, by changing the pitch (stress) (Nazzi et al., 1998), or by inserting a pause (Lange-Küttner et al., 2015; Männel et al., 2015; Männel & Friederici, 2009; Mueller et al., 2008), both of which creates contrast and boundaries within the stream of language or the flow of music. These are temporal modulations which occur both in music and speech (Ding et al., 2017) and do not need to involve meaning. For instance, in another recent study, a piece of newly composed instrumental music lasting 2 minutes and 15 seconds during encoding generated superior shape memory when the shape and the beat co-occurred rather than were out of synchrony (Hickey et al., 2020).

The current study has some limitations. We conducted only one experiment without a replication yet. There may have been significant interactions given a larger sample size, however, the p-values for the interactions were not approaching significance. We did find some gender differences which we do not report because we did not have a sex-balanced sample, with more women than men in each group. Nevertheless, we believe that our demonstration that the Mozart effect produces superior word memory when implemented during the memory delay provides strong experimental evidence that Mozart’s and Mahler’s music have an enhancing or degrading effect on the word memory trace itself.
Appendix

Table A1: Word Categories (negative, neutral, positive) matched for Word length by Syllables

| Target Words | Frequency | Syllables | Letters | Negative Words | Frequency | Syllables | Letters |
|--------------|-----------|-----------|---------|----------------|-----------|-----------|---------|
| problem      | 565       | 2         | 7       | patient        | 242       | 2         | 7       |
| death        | 230       | 1         | 5       | court          | 344       | 1         | 5       |
| issue        | 269       | 2         | 5       | reason         | 289       | 2         | 6       |
| test         | 159       | 1         | 4       | force          | 250       | 1         | 5       |
| loss         | 154       | 1         | 4       | cost           | 269       | 1         | 4       |
| anger        | 34        | 2         | 5       | abuse          | 37        | 2         | 5       |
| bomb         | 39        | 1         | 4       | cold           | 25        | 1         | 4       |
| devil        | 20        | 2         | 5       | horror         | 26        | 2         | 6       |
| stress       | 42        | 1         | 6       | rape           | 20        | 1         | 4       |
| breach       | 35        | 1         | 6       | guilt          | 18        | 1         | 5       |

| Positive Words | Frequency | Syllables | Letters | Neutral Words | Frequency | Syllables | Letters |
|----------------|-----------|-----------|---------|---------------|-----------|-----------|---------|
| party          | 529       | 2         | 5       | music         | 150       | 2         | 5       |
| love           | 150       | 1         | 4       | heart         | 152       | 1         | 5       |
| parent         | 201       | 2         | 6       | morning       | 219       | 2         | 7       |
| friend         | 315       | 1         | 6       | home          | 390       | 1         | 4       |
| health         | 246       | 1         | 6       | light         | 191       | 1         | 5       |
| beauty         | 44        | 2         | 6       | bonus         | 18        | 2         | 5       |
| kiss           | 19        | 1         | 4       | mate          | 25        | 1         | 5       |
| humour         | 23        | 2         | 6       | favour        | 28        | 2         | 6       |
| luck           | 32        | 1         | 4       | laugh         | 19        | 1         | 5       |
| joke           | 33        | 1         | 4       | charm         | 15        | 1         | 5       |

| Neutral Words | Frequency | Syllables | Letters | Neutral Words | Frequency | Syllables | Letters |
|---------------|-----------|-----------|---------|---------------|-----------|-----------|---------|
| service       | 549       | 2         | 7       | table         | 231       | 2         | 5       |
| sense         | 229       | 1         | 5       | land          | 208       | 1         | 4       |
| paper         | 237       | 2         | 5       | product       | 217       | 2         | 7       |
| month         | 398       | 1         | 5       | name          | 326       | 1         | 4       |
| face          | 315       | 1         | 4       | hour          | 302       | 1         | 4       |
| reply         | 36        | 2         | 5       | album         | 26        | 2         | 5       |
| zone          | 37        | 1         | 4       | palm          | 19        | 1         | 4       |
| painter       | 20        | 2         | 7       | monkey        | 11        | 2         | 6       |
| moon          | 31        | 1         | 4       | bell          | 28        | 1         | 4       |
| view          | 44        | 1         | 4       | print         | 34        | 1         | 5       |
REFERENCES

Bangerter, A., & Heath, C. (2004). The Mozart effect: Tracking the evolution of a scientific legend. *British Journal of Social Psychology, 43*(4), 605–623. [https://doi.org/10.1348/01446660424565353]

Brackney, D. E., & Brooks, J. L. (2018). Complementary and alternative medicine: The Mozart effect on childhood epilepsy - a systematic review. *The Journal of School Nursing, 34*(1), 28–37. [https://doi.org/10.1177/1059840517740940]

Ding, N., Patel, A. D., Chen, L., Butler, H., Luo, C., & Poeppel, D. (2017). Temporal modulations in speech and music. *Neuroscience & Biobehavioral Reviews, 81*, 181–187. [https://doi.org/10.1016/j.neubiorev.2017.02.011]

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. [https://doi.org/10.3758/bf03193146]

Ferreri, L., & Verga, L. (2016). Benefits of music on verbal learning and memory: How and when does it work? *Music Perception: An Interdisciplinary Journal, 34*(2), 167–182. [https://doi.org/10.1525/mp.2016.34.2.167]

Friederici, A. D., & Oberecker, R. (2008). 9. The development of syntactic brain correlates during the first years of life. In *Early Language Development* (pp. 215–231). John Benjamins Publishing Company. [https://doi.org/10.1075/tilar.5.11fri]

Friedrich, M., & Friederici, A. D. (2008). Neurophysiological correlates of online word learning in 14-month-old infants. *NeuroReport: For Rapid Communication of Neuroscience Research, 19*(18), 1757–1761. [https://doi.org/10.1097/wnr.0b013e328358f014]

Giannouli, V., Kolev, V., & Yordanova, J. (2019). Is there a specific Vivaldi effect on verbal memory functions? Evidence from listening to music in younger and older adults. *Psychology of Music, 47*(3), 325–341. [https://doi.org/10.1177/0305735618757901]

Hickey, P., Merseal, H., Patel, A. D., & Race, E. (2020). Memory in time: Neural tracking of low-frequency rhythm dynamically modulates memory formation. *NeuroImage, 213*, 116693. [https://doi.org/10.1016/j.neuroimage.2020.116693]

Holden, C. (2003). Mozart “Effect” Revisted. *Science, 301*(5635), 914b–9914. [https://doi.org/10.1126/science.301.5635.914b]

Ivanov, V. K., & Geake, J. G. (2005). The Mozart Effect and primary school children. *Psychology of Music, 31*(4), 405–413. [https://doi.org/10.1177/0305735603314005]

Jones, M. H., & Estell, D. B. (2007). Exploring the Mozart effect among high school students, *Psychology of Aesthetics, Creativity, and the Arts, 1*(4), 219–224. [https://doi.org/10.1057/1931-3896.1.4.219]

Jones, M. H., West, S. D., & Estell, D. B. (2006). The Mozart effect: Arousal, preference, and spatial performance. *Psychology of Aesthetics, Creativity, and the Arts, 1*(1), 26–32. [https://doi.org/10.1057/1931-3896.1.1.26]

Lange-Küttner, C., & Finn, C. (2008). Musical notation and fine motor skills when playing the soprano recorder: Making a neural network lift a finger. In M. Schlesinger, L. Berthouze, & C. Balkenius (Eds.), *Procedings of the 8th International Conference on Epigenetic Robotics: Modeling cognitive development in robotic systems* (Vol. 139, pp. 69–76). Lund University Cognitive Studies. [http://www.informatics.sussex.ac.uk/events/epirob/Papers/Lange-Kuettner%20Paper%20Epirob08.pdf]

Lange-Küttner, C., Markowska, M., & Kochhar, R. (2017). Deterioration and recovery in verbal recall: Repetition helps against pro-active interference. *Psychological Test and Assessment Modeling, 31*(4), 405–441. [http://www.psychologie-aktuell.com/fileadmin/ptam/4-2017_20171218/02_Lange.pdf]

Lange-Küttner, C., Puiu, A.-A., Nylund, M., Cardona, S., & Garnes, S. (2013). Speech preparation and articulation time in bilinguals and men. *International Journal of Speech & Language Pathology and Audiology, 1*(1), 37–42. [https://doi.org/10.12970/2511-1917.2013.01.01.5]

Lange-Küttner, C., & Sykorova, E. (2015). Mojibake - The rehearsal of word fragments in verbal recall. *Frontiers in Psychology, 06*. [https://doi.org/10.3389/fpsyg.2015.00350]

Leech, G., Rayson, P., & Wilson, A. (2014). *Frequencies in written and spoken English: Based on the British National Corpus*. Routledge. [https://doi.org/10.4324/9781315840161]

Lim, H. A., & Park, H. (2018). The effect of music on arousal, enjoyment, and cognitive performance. *Psychology of Music, 47*(4), 539–550. [https://doi.org/10.1177/0305735618766707]
Lin, L.-C., Lee, W.-T., Wu, H.-C., Tsai, C.-L., Wei, R.-C., Mok, H.-K., Weng, C.-F., Lee, M., & Yang, R.-C. (2011). The long-term effect of listening to Mozart K.448 decreases epileptiform discharges in children with epilepsy. Epilepsy & Behavior, 21(4), 420–424. https://doi.org/10.1016/j.yebeh.2011.05.015

Lyubomirsky, S., & Lepper, H. S. (1999). A measure of subjective happiness: Preliminary reliability and construct validation. Social Indicators Research, 46(2), 137–155. https://doi.org/10.1023/a:1006824100041

Macmillan, N. A., & Creelman, C. D. (2005). Detection theory: A user's guide (Second edition). Erlbaum.

Männel, C., & Friederici, A. D. (2009). Pauses and intonational phrasing: ERP studies in 5-month-old German infants and adults. Journal of Cognitive Neuroscience, 21(10), 1988–2006. https://doi.org/10.1162/jocn.2009.21221

Männel, C., Schipke, C. S., & Friederici, A. D. (2013). The role of pause as a prosodic boundary marker: Language ERP studies in German 3- and 6-year-olds. Developmental Cognitive Neuroscience, 5, 86–94. https://doi.org/10.1016/j.dcn.2013.01.003

McKelvie, P., & Low, J. (2002). Listening to Mozart does not improve children's spatial ability: Final curtains for the Mozart effect. British Journal of Developmental Psychology, 20(2), 241–258. https://doi.org/10.1348/026151002651002166433

Mueller, J. L., Bahmann, J., & Friederici, A. D. (2008). The role of pause cues in language learning: The emergence of event-related potentials related to sequence processing. Journal of Cognitive Neuroscience, 20(5), 892–905. https://doi.org/10.1162/jocn.2008.20511

Nantais, K. M., & Schellenberg, E. G. (1999). The Mozart effect: An artifact of preference. Psychological Science, 10(4), 370–373. https://doi.org/10.1111/1467-9280.00170

Nazzi, T., Floccia, C., & Bertoncini, J. (1998). Discrimination of pitch contours by neonates. Infant Behavior and Development, 21(4), 779–784. https://doi.org/10.1016/s0163-6383(98)90044-5

Nazzi, T., & Houston, D. (2006). Finding verb forms within the continuous speech stream. In K. Hirsh-Pasek & R. M. Golinkoff (Eds.), Action Meets Word: How children learn verbs (pp. 64–87). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195170009.003.0003

Nguyen, T., & Grahn, J. A. (2017). Mind your music: The effects of music-induced mood and arousal across different memory tasks. Psychomusicology: Music, Mind, and Brain, 27(2), 81–94. https://doi.org/10.1037/pmu0000178

Patel, A. D. (2008). Music, language and the brain. Oxford University Press.

Rauscher, F. H., & Hinton, S. C. (2006). The Mozart Effect: Music listening is not music Instruction. Educational Psychologist, 41(4), 233–238. https://doi.org/10.1207/s15326985ep4104_3

Rauscher, F. H., Shaw, G. L., & Ky, K. N. (1993). Music and spatial task performance. Nature, 365(6447), 611–611. https://doi.org/10.1038/365611a0

Rauscher, F. H., Shaw, G. L., & Ky, K. N. (1995). Listening to Mozart enhances spatial-temporal reasoning: Towards a neurophysiological basis. Neuroscience Letters, 185(1), 44–47. https://doi.org/10.1016/0304-3940(94)11221-4

Scott, S. K. (2005). The neurobiology of speech perception. In A. Cutler (Ed.), Twenty-first century psycholinguistics: Four cornerstones (pp. 141–156). Erlbaum.

Smith, J. C., & Joyce, C. A. (2004). Mozart versus New Age Music: Relaxation states, stress, and ABC relaxation theory. Journal of Music Therapy, 41(3), 215–224. https://doi.org/10.1093/jmt/41.3.215

Steele, K. M., Bass, K. E., & Crook, M. D. (1999). The mystery of the Mozart effect: Failure to replicate. Psychological Science, 10(4), 366–369. https://doi.org/10.1111/1467-9280.00169

Storbeck, J., & Clore, G. L. (2005). With sadness comes accuracy; with happiness, false memory: Mood and the false memory effect. Psychological Science, 16(10), 785–791. https://doi.org/10.1111/j.1467-9280.2005.01615.x

Talero-Gutiérrez, C., & Saade-Lemus, S. (2018). Demystifying the Mozart effect: Facts beyond the controversy. In I. González-Burgos (Ed.), Psychobiological, clinical, and educational aspects of giftedness (pp. 67–85). Nova Biomedical Books.

Thompson, W. F., Schellenberg, E. G., & Husain, G. (2001). Arousal, mood, and the Mozart effect. Psychological Science, 12(3), 248–251. https://doi.org/10.1111/1467-9280.00345
Toukhssati, S. R., & Rickard, N. S. (2012). The Mozart Effect: An opportunity to examine the cognitive neuroscience of music listening. In N. S. Rickard & K. McFerran (Eds.), Lifelong engagement with music: Benefits for mental health and well-being (pp. 183–208). Nova Science Publishers.

Verrusio, W., Ettorre, E., Vicenzini, E., Vanacore, N., Cacciafesta, M., & Mecarelli, O. (2015). The Mozart effect: A quantitative EEG study. Consciousness and Cognition: An International Journal, 35, 150–155. https://doi.org/10.1016/j.concog.2015.05.005

Waterhouse, L. (2006a). Inadequate evidence for multiple intelligences, Mozart Effect, and emotional intelligence theories. Educational Psychologist, 41(4), 247–255. https://doi.org/10.1207/s15326985ep4104_5

Waterhouse, L. (2006b). Multiple intelligences, the Mozart Effect, and emotional intelligence: A critical review. Educational Psychologist, 41(4), 207–225. https://doi.org/10.1207/s15326985ep4104_1

Yen-Ning, S., Chih-Chien, K., Chia-Cheng, H., Lu-Chun, P., Shu-Chen, C., & Yueh-Min, H. (2017). How does Mozart’s music affect children’s reading? The evidence from learning anxiety and reading rates with e-Books. Journal of Educational Technology & Society, 20(2), 101–112. http://www.jstor.org/stable/90002167