

Hearing Double Auditory Scene Analysis while Inebriated

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Background

From a tangle of separate pitches the human brain is able to construct one or more continuous streams of tones. This ability of the brain's auditory gestalt perception has been studied in the field of auditory scene analysis (ASA, i.a. Bregman 1990). Well known early findings are the *trill threshold* (Miller & Heise 1950) and the discovery of the *principle of rhythmic fission and temporal coherence* (van Noorden 1975).

Two alternating tones are perceived as one continuum or as two separate tones depending on their interval size and tempo. With fast tempi (10-20 tones/sec) and interval sizes above a minor third the two alternating tones are heard as two interwoven streams. With slower tempo the interval size has to be enlarged to get this perception of rhythmic fission. With an interval size of a minor second the two alternating tones are heard as one sole melodic stream independent of the tempo. Between these values the focus of attention is crucial for deciding how the alternating tones are perceived. While inebriated the processing of the sensory information can be disturbed (Fachner 2004), additionally alcohol disturbs memory, activation and the focus of attention (Curtin et al. 2001). In her master's thesis Tiihonen (Tiihonen et al. 2013) was able to show that alcohol reduces the amount of music induced chills. This result raised the question, how alcohol interferes the process of music listening; whether alcohol disturbs the emotional attribution of meaning or the cognitive process of the auditory perception itself. This pilot study addresses the latter question, since the used stimuli are of non-aesthetic character. Rather than hypothesis testing, the main goal of this study is to search for a suitable method to address the above mentioned question.

Research Question and Hypotheses

Research Question: Does the tempo/interval based melodic splitting change while inebriated?

Hypotheses:

H1: Alcohol does not have an impact on the perception of the frequencies of the critical bandwidth because it is considered to be a physiological constant. Therefore intervals below a minor 3rd should be perceived as one sole melodic stream independent of the tempo or of the inebriation.

H2: When inebriated, the fission boundary is expected to increase; above a minor 3rd either the tempo should be faster or the interval should be larger in order to hear two interwoven melodic streams.

Methods

20 participants were tested with and without alcohol within a cross-over replicate-study-design. The here used 36 stimuli of the van Noorden paradigm were minor 2nd, minor 3rd, 5th, 7th, 9th and 12th. All of them were heard at tempi of 3, 5, 7, 10, 15 and 20 tones/second. After each randomly presented stimulus, the participants were asked if they heard one or two streams.

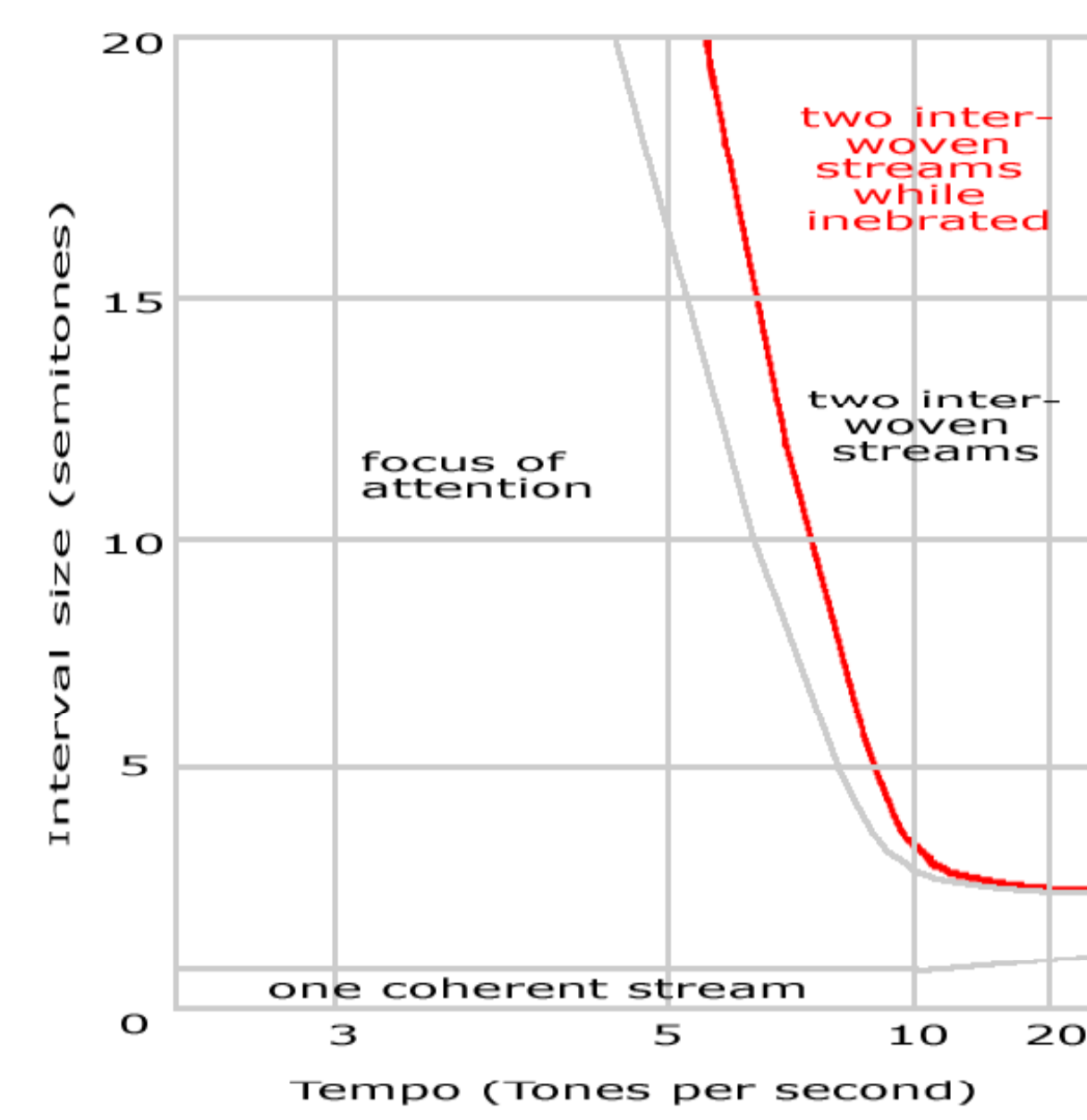
In the inebriation condition the participants were provided with orange juice and vodka. The level of alcohol intoxication (0,5 - 0,8 permil) was controlled by a breathalyser (Dräger 7410).

Results

The influence of alcohol was analysed for within-factors using a 2x3 ANOVA. The following effects were found: Inebriated did not differ from the not inebriated, $p[df=1; F=0,010] = 0,923$. The three regions significantly differed from each other, $p[df=2; F=255,786] < 0,000$, but there was no interaction between the factors, $p[df=2; F=0,435] = 0,650$. This means that alcohol had no significant effect on the stream segregation regarding the perception of one coherent stream vs. two interwoven streams vs. focus of attention.

Unexpectedly, the stream segregation curve of the collected data seems to be different from the results of van Noorden's observations. Mostly two streams were heard at slow tempi or at slightly faster tempi with large intervals. The data shows a tendency in which an increasing tempo leads to the perception of one stream, while an increasing interval size leads to the perception of two streams.

Results



After the observations of van Noorden (1975) the regions of tempo- and interval size dependent melodic perception are circumscribed by the *coherence boundary* (below it alternating pitch is perceived as one coherent melodic stream) as well as by the *fission boundary* (above it alternating pitch is perceived as two interwoven streams). When inebriated the coherence boundary should remain the same while the fission boundary should increase.

Sums of "1 Stream" answers per stimulus

		Without alcohol						With alcohol					
Interval	Tempo	Without alcohol						With alcohol					
		12 th	2	4	3	4	6	10	2	5	4	6	3
9 th	3	3	3	5	8	10	3	2	1	4	7	8	
7 th	2	6	5	2	10	12	4	3	3	7	8	11	
5 th	6	3	5	12	11	11	3	3	5	8	9	12	
3 rd	7	6	13	14	15	14	5	7	14	12	11	15	
2 nd	10	8	14	14	17	16	9	13	15	16	19	16	

Sums of "2 Streams" answers per stimulus

		Without alcohol						With alcohol					
Interval	Tempo	Without alcohol						With alcohol					
		12 th	17	17	15	14	10	10	19	16	17	15	15
9 th	16	18	17	14	9	9	18	19	20	16	10	9	
7 th	17	14	15	18	8	7	17	18	17	14	11	9	
5 th	15	17	16	9	8	8	18	16	14	12	11	8	
3 rd	11	14	7	3	6	5	16	12	6	7	8	6	
2 nd	11	11	4	7	3	5	12	7	4	4	1	3	

Conclusion

All in all it could be shown that the auditory scene analysis is not influenced by the consumption of alcohol (0,5 - 0,8 permil). Especially small intervals (minor 2nd) are mostly heard as one melodic stream, independent of the tempo and of the inebriation. This can be interpreted as an indication of the critical bandwidth as a reason for coherent melodic perception. Unexpectedly the participants perceived wide intervals at fast tempi mostly as one sole stream.

Further Research Questions

Since the results at fast tempi and large intervals are in contrast with those of van Noorden's, a replication of his study is deemed reasonable, especially because he had only from 1 to 3 participants. Additionally, the experiment presented here should be replicated with a more extensive and accessible introduction of the stimuli to the participants.

Thanks to

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Source: <https://github.com/ramonh/StreamTest>

Literature

Bregman, A.S. (1990). Auditory Scene Analysis. Cambridge, Mass.: Bradford Books, MIT Press. - Curtin, J.J. et al. (2001). Alcohol affects Emotion through Cognition. Psychological Science 12(6), 526-531. - Fachner, J. (2004). Musik, Drogen und veränderte Wachbewusstseinszustände. Universität Witten/Herdecke, 1-32. - Miller, G.A.; Heise, G.A. (1950). The trill threshold. JASA 22, 637-638. - Tiihonen, M., Von Georgi, R., Reuter, C., Laczika, K.: "What a Wonderful World" - Der Einfluss von Alkohol auf musikinduzierte Chills. "Musik und Familie" - Jahrestagung 2013 der Deutschen Gesellschaft für Musikpsychologie (DGM), HfMDK Frankfurt, 6.- 8. September 2013. - van Noorden, L.P.A.S. (1975). Temporal coherence in the perception of tone sequences. Unpublished doctoral dissertation, Technische Hogeschool Eindhoven, Eindhoven, the Netherlands.