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A CONSTRUCT-PSYCHOLOGICAL APPROACH TO THE MEASUREMENT OF CHILL-SENSATIONS

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1. Introduction

Many authors consider music as an emotional form of communication through which is it is not only possible to express and convey emotions, but also to directly evoke them in a recipient (Juslin/Sloboda 2001). Independently of theoretical approach, emotions can be described on at least three levels of reaction (see Fahrenberg 1992; Hamm 1993; Traue 1998; Altenmüller/Kopiez, 2005; von Georgi 2006; Grewe et al 2007a): a) the physiological level (e.g. changes in heart rate, galvanic skin response or hormone production), b) the motor level (facial musculature, movement) and c) the cognitive-affective level (feelings of joy or anxiety or of a positive or negative affect; e.g. Van Oyen Witvliet/Vrana 1995; Rickard 2004; Grewe 2007; Grewe et al. 2007a; Nagel 2007; Guhn et al. 2007). Without going into various emotion theories of the last decades, it is necessary to stress that emotions are more than the sole result of cognitive interpretations of physiological states (see Schachter/Singer 1962; Lazarus/Folkman 1984; Lazarus 1991). Moreover, they can be induced directly without primary cognitive involvement (LeDoux 2000; Zald 2003). Chills are known to be among the strongest emotional responses to music. Regarded as a special case of the broader concept of SEMs (strong experience in music) (Gabrielsson/ Lindström 1993; Gabrielsson 2001; Gabrielsson/Lindström 2003), they con-

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stitute very strong emotional reactions to musical stimuli. This emotional reaction often involves goose bumps, a feeling of surprise and a strong positive or negative affect (Goldstein 1980; Panksepp 1995). The biological/ psychological function of chills is not clear and research is mainly focused on two major aspects thereof: physiological, biological and neurological mechanisms underlying the chill-reaction as well as the identification of possible musical characteristics considered as stimuli of chill-sensations.

Blood/Zatorre (2001) showed the activation of those areas of the brain during chill-sensations that are part of the reward system. This system is involved in positive and behavioral-activating emotions. On the basis of their research the authors surmise that music perceived as pleasurable inhibits the activation of those brain systems involved in signaling of uncomfortable emotions such as anxiety or aversion. The fact that 77% of subjects of this study described chills as positive sensations and also showed brain activation similar to when eating good foods, having sex or taking drugs, may be explained by the subjects' ability to chose their own music (in a control study involving different pieces of music, chills were reported in hardly any case).

Panksepp (1995) on the other hand associates chills with sad and painful emotions of social loss and yearning. The acoustic triggers of chills identified by him were mainly the crescendo of music or the isolation of a single instrument from the total orchestral sound. Panksepp/Bernatzky (2002) base the chill-phenomenon on an evolutionarily old biological signaling system. If, for example, mother and offspring loose eye-contact, then the cry of the mother will induce a stereotypical reaction in the offspring, whereby its hairs stand up to increase skin temperature and a feeling of safety and security.

Other researches find changes in physiological and neurological parameters coinciding with chill-sensations (Nagel 2007; Guhn et al. 2007). These include heart and breathing rate, galvanic skin response, skin and body temperature (see also Panksepp/Bernatzky 2002) and increased blood flow to regions of the brain associated with motivation, reward and approach behavior as well as the perception of positive affects (Francis et al. 1999; Gray/McNaughton 2000; Blood/Zatorre 2001; McNaughton/Corr 2004). Recent findings of Grewe (2006) or Konečni et al. (2007) allow for the conclusion that an emotional connection to certain pieces or genres of music is important for chill-sensations. The probability of chills during music of low subjective preference is minimal. Therefore chills can be promoted by expectations or imaginations. This favors the supposition that chills are represented mentally (Altenmüller et al. 2007).

Regarding musical characteristics, no universal traits (e.g. certain harmonies or rhythms) could be isolated to date (Grewe et al. 2005). A simple pattern of stimulus and reaction is therefore highly unlikely (Altenmüller et al. 2007). Even so, certain musical events could be identified, which appear to be connected to chills: For example the onset of vocals or a specific theme or motif or a structurally new part as well as changes in music volume (be it sudden or as a crescendo), increased roughness or the contrast of two voices (Grewe 2007; Guhn et al. 2007). As subjects show high consensus in evaluating the potential of a musical piece for inducing chills, it is highly likely that there is a biological sensibility for such musical phenomena (see Blood/Zatorre 2001; Nagel 2007). This is also underlined through the identification of chill-sensations in various cultures (McCrae 2007).

Next to the biological/physiological approaches the research on psychological importance and on possible individual differences regarding chill-sensations is poorly developed. Research is mostly limited to the measurement of the situation-dependent base affects valence (happy/sad) and arousal (mildly/strongly aroused), which should undermine the hard biological data, rather than contribute to the contentual and theoretical clarification of the psychological meaning of chills. This may also explain why inventories of personality have never been applied to date, even though a number of articles show the connection between emotional reactivity and personality (e.g. Zuckerman 1991; Gray/McNaughton 2000). The one exception is the study by Grewe (2007; see also Grewe et al. 2007a, 2007b). This study showed that persons classified as chill-responders had low values regarding »thrill and adventure seeking« — a subtrait of sensation seeking (Zuckerman 1979; Roth/Hammelstein 2003) — as well as high reward orientation. These and other results allow for the conclusion that strong or frequent chill-sensations are often found in persons with high positive affectivity (reward orientation) as well as low tolerance thresholds for strong stimuli (sensation seeking). Grewe et al. (2007b) postulate a »chill-personality« on the basis of their research.

Although these interpretations seem attractive at first glance, the results of Grewe (2007) need to be critically questioned. First of all, most chills were described during excerpts of Mozart's »Tuba Mirum« (Requiem KV 626) and Bach's »Toccata« (BWV 540). This may indicate that the findings are only valid for lovers of so-called classical music. Furthermore, the sample is overly comprised of musicians as well as women (5 professional and 20 amateur musicians, and 13 non-musicians with a mean age of 38 years [9 men and 33 women]). Buttsworth/Smith (1995) showed high intersexual differences especially in the personality profiles of musicians. It is therefore

likely that the »chill-responders« of Grewe (2007; see Grewe et al. 2007a, 2007b) generally exhibit low »thrill and adventure seeking«, which in turn need not necessarily be linked to their susceptibility for chills. It should also be critiqued that the group was divided into chill-responders (n=21) and non-responders (n=17), which implies that non-responders have lower or no over-all chill-reactivity. This is in contrast to findings of Sloboda (1991), that chills are experienced by far more people than is found in experimental settings. Table 1 shows that 90% of a sample of n=83 know chill-sensations and experience them consciously. Furthermore, tears are a more common aspect of chills in women, and persons between 30 and 40 laugh more often during chills than those of other age groups. The high variability in psychological representation of physiological/emotional reaction shown by this simple descriptive table is indicative of valid inter- and intra-individual differences.

Table 1:
Physical reactions to music

Subjective chill-reactions to music within the last five years	M	%
Shivers down the spine	3,08	90
Laughter	2,80	88
Lump in the throat	2,68	80
Tears	2,65	85
Goose pimples	2,40	62
Racing heart	2,31	67
Yawning	2,15	58
Pit of stomach sensations	2,11	58
Sexual arousal	1,56	38
Trembling	1,51	31
Flushing/blushing	1,46	28
Sweating	1,44	28

Sample: 83 listeners of music, thereof 34 professional musicians, 33 amateurs and 16 laypersons between 16 and 70 years. M: arithmetic mean (1=never; 2=seldom; 3=occasionally; 4=often; 5=very often); %: amount of entries in percent (Sloboda 1991: 112).

These results suggest that chills are not rare or isolated occurrences, but are likely to be bound strongly to everyday life and therefore coincide with specific situational, personal and cultural variables (e.g. Konečni et al. 2007), which are difficult to simulate, manipulate or control in laboratory settings. This critique leads to the demand that apart from experimental research there need be an approach allowing for research on chills independently of laboratory settings. Surely the works of Sloboda (1991) or Panksepp (1992) are steps in the right direction. They do, however, disguise the fact that to date no reliable statement can be made regarding the strength and manner of chill-sensations depending on situational or personal va-

riables. In other words: although chills are a matter of research and their importance for emotional reception of music is emphasized often, nothing is known about their habitual psychological representation due to the lack of suitable inventories or concepts.

2. Problem and question

To date chills have been mainly measured in experimental settings, wherefore the examination of global variables (e.g. musical preference, personality or other trait-related measurements) has not been possible. This is linked to the fact that the measured music-related chills are of high validity, but exhibit a strong situational character, wherefore relations to trait-equivalent parameters need to be viewed upon as unreliable (see above) from a theoretical point of view. Furthermore, the experience of chills in specific situations is well described in the dimensions of the base affects and the physiological reactivity, but there is no concrete conception of how chills are represented as a psychologically stable construct.

The pilot study at hand addresses the aforementioned restrictions and problem for the first time. The following questions were primarily dealt with: a) is chill represented not only situationally, but as a stable construct measureable through psychometric inventories? b) Should there be a representation of »the chill«, or is the chill-sensation multi-dimensional? c) What are the relations between this psychological representation and descriptive measures (age or sex) as well as personality variables? d) Are the experimental results replicable and which differences can be found?

3. Methods

3.1 Construction of the chill-questionnaire

In a first study on one sample a questionnaire with items on general chill-sensations was developed. Subjects were instructed to write down how they perceived music-related chills subjectively and with which reactions these were linked. Apart from items constructed from these open descriptions, others were created according to the aforementioned state of the art. Finally items were incorporated that resulted from personal interviews between the members of our group and friends and colleagues. The result was a questionnaire with 77 items, which were answerable on a four-step Likert-

scale (0= does not apply; 3=applies highly). All items were given in a uniform format: »When I experience or have experienced a chill, then…« followed by the respective item (e.g. »…I get goose bumps«, »…I become afraid of losing control«, »…I feel like my legs turn into jelly« etc.). Some items were added regarding social defensive demeanor or emotional indisposition (e.g. »…I hope that nobody noticed«). The so devised questionnaire was given to another sample of n=15 for revision. They were asked to mark problematic wording such as ambiguity or logical inconsistencies and report these after reviewing the questionnaire. The resulting questionnaire was christened the MRCQ (Music Related Chill Questionnaire) and shall be abbreviated in this fashion through the remainder of the manuscript. The MRCQ was then applied to another sample (study 2) in order to assess the possible underlying dimensions of chill-sensations through item and scale analyses and allow for the first psychometric measurability of chills. During construction no heed was paid to differences between the sexes, as the questionnaire is meant to measure those aspects of the construct that are shared by men and women alike, where through a comparison between sexes will be possible.

3.2 Subjects

The participants of study 1, wherein the chill-sensations were assessed in half-standardized questions, were n=151 medical students in their first semester (93 males, 58 females). Mean age was 21 (SD=2.1, Md=20, Min=18, Max=34). All Participants were asked to fill in the questionnaire during a lecture given by one of our investigators. In study 2 the MRCQ was dispensed by 4 investigators to 123 participants of various age-groups, sex, education and job class. It was made sure that the participants were not members of the researches personal environment (such as partners, friends, family, fellow students etc.) in order to minimize the risk of data distortion through social acceptability. The mean age of this group was 24 (SD=6,8, Md=23, Min=16 Max=52). 66 participants of study 2 were female and 52 were male.

3.3 Inventories used

Apart from the constructed MRCQ, individual differences were assessed with the NEO-ffi (Neuroticism-Extraversion-Openness to Experience-Five-Factor Inventory by Costa and McCrea [Borkenau/Ostendorf 1993]). The NEO-ffi is among the most renowned personality inventories, measuring personality characteristics on the dimensions neuroticism (N: emotional instability), extraversion (E: sociability and self-assurance), openness to experience (OE: engagement in new experiences, impressions and adventures), agreeableness (A: altruism, need for harmony, cooperation) and conscientiousness (C: self control during planning, organization and execution of tasks) (von Georgi 2002). In order to assess possible connections to the usage of music for activation and arousal modulation in everyday life through music, we also applied the IAAM (Inventory for the Assessment of activation and Arousal-modulation through Music [von Georgi et al. 2006; 2007]). The IAAM measures differences between groups regarding the personality-dependent usage of music for relaxation (RX), cognitive problem solving (CP), reduction of negative activation (RA), fun stimulation (FS) and arousal modulation (AM). Both the NEO-ffi and the IAAM are marked through excellent reliability and validity.

3.4 Data analyses

The open answers regarding chill-sensations from study 1 were analyzed as follows: unambiguous answers were sorted according to their tenor into corresponding congruent categories. The remaining answers were sorted into newly-formed categories. The resulting system of categories was assessed using descriptive frequency analyses.

In order to establish a quantifiable measurement of chill-sensations, the items of the MRCQ were checked for floor or ceiling effects (left- or right-skewed distributions). Furthermore, all items, whose distribution was limited to two or less categories, were excluded. This should not only identify statistically unfit items, but also prevent distribution-based spurious correlations between items. Items of which the mean and the mode strongly deviate from each other or such with standard deviations below 1 were also excluded. After this sifting, 41 of the initial 77 items remained and explorative factor analyses were performed (Varimax-rotaion, principal axis factoring). After selecting those items with the highest factor loadings and least multiple loadings the respective items were grouped according to their

factor and assessed through scale analyses. The scales were optimized according to items' discriminative powers (corrected item-total-correlation) and the scale's reliability approximation through Chronbach's Alpha (α, internal consistency). Analyses of variance and correlation-analyses were performed for each resulting scale regarding differences in reported subjective intensity of chill, differences in sex, personality and differences in the usage of music for activation and arousal-modulation.

4. Results

4.1 Study 1

4.1.1 Forms of subjective chill-sensations

Overall the participants indicated a maximum of seven different descriptions of subjective chill-sensations. Diagram 1 shows the number of various nominations. Although 95% of participants reported having had experienced chills, 28% did not give any description as to their subjective sensations.

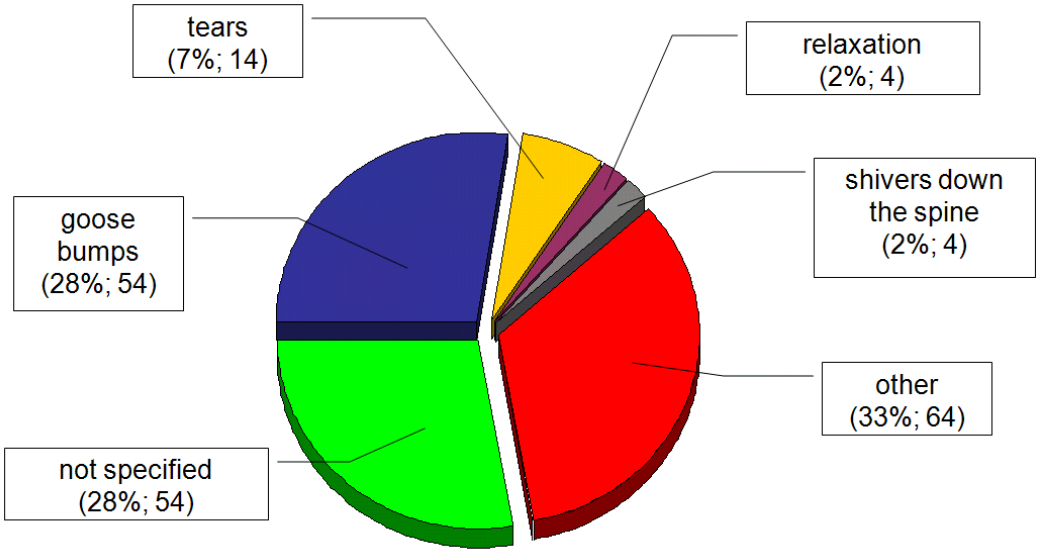

Diagramm 1: Percentaged and absolute frequencies of unambiguous answers to the question: »Which sensations do you experience during a musically induced chill?«

Apart from the category »others« (see below), the most common answer is »goose bumps«. Unlike the incidence of »tears«, the sensation of »shivers down my spine« appears only rarely.

The composition of the category »others« is shown in diagram 2. Again it can be shown that tickling, shivering or trembling sensations are quite

common. But also positive emotions like happiness and joy or the feeling of floating or of disengagement as well as pondering things past (cognition) are mentioned. The size of the rest-category (33%) is also striking. This is comprised of a number of nominations or reactions that could not be put into any category without significant loss of meaning.

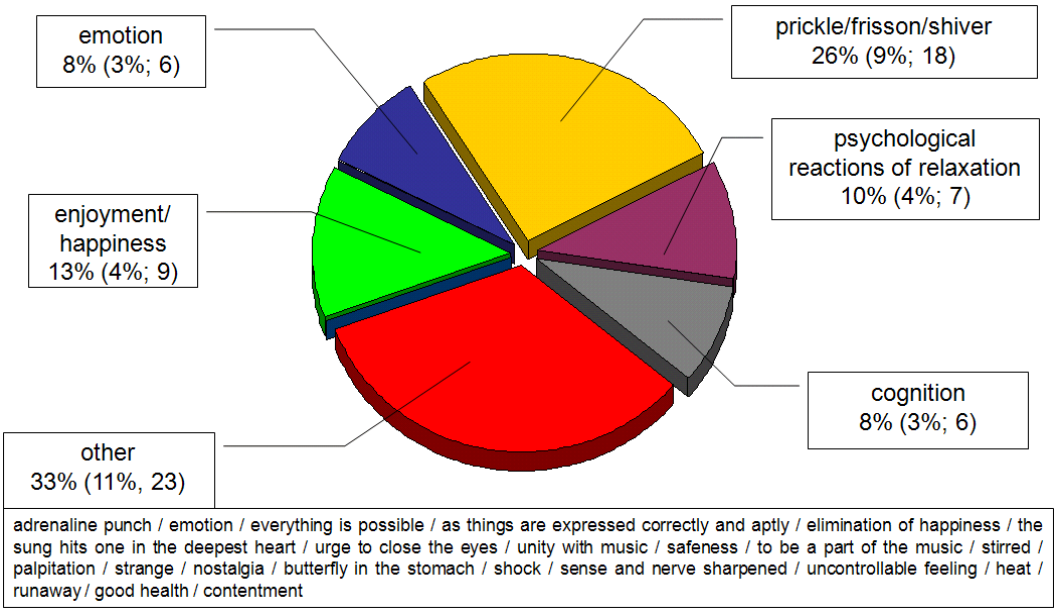

Diagramm 2: Percentaged frequencies of ambiguous nominations within the category »others« from diagram 1 (n=64); the figures in brackets show the percentage relative to the entire sample as well as the absolute frequencies.

4.1.2 Summary of study 1

At first glance the results of the qualitative answers of the participants agree with those from experimental research. Upon closer look, however, certain distinct differences attract attention. These shall be pondered within the final discussion. At this point it needs to be stressed that the reports of chill-sensations by 94% of participants are significantly higher than in clinical studies. This means that chills, as are examined in laboratory settings, only apply to a small amount of persons. The larger portion of participants is familiar with chill-sensations, but cannot experience them within laboratory situations. This seems to indicate either that only a certain kind of chill may be induced in a laboratory or that only a specific sample of persons has been surveyed in the past. It is also important to note that within this simple analysis a higher variability of chill-sensations can be found than was previously assumed. Obviously classical »goose bumps« are most common, but there are a great number of other reactive tendencies, which incorporate both cognitive and motor facets. This goes to show that

there are possibly different basic areas in which chills represent themselves.

4.1 Study 2

4.2.1 Descriptive Data

Below there will be a short description of the analysis of the descriptive variables regarding chill-sensations. The results from the first study clearly show that most people are familiar with music-induced chills. The question »Have you ever had a chill related to music?« was answered »Yes, often« by 34% (37) of participants, »Yes, on occasion« by 44% (47), »Yes, but only rarely« by 20% (22) and »Yes, in the past, but not any more« by 2% (2) (x^2=42.59; df=3; p≤0.001). When asked »How many seconds does an average chill last?« 33% (36) indicated 1-5 seconds, 39% (42) 5-10 seconds, 17% (18) 10-20 seconds and 11% (12) longer than 20 seconds (x^2=22.68; df=3; p≤0.001).

Table 2:
Percentaged and absolute frequencies of chill-related descriptive variables

Question	Yes	No	x^2[FG=1]	p
Do you experience chill easily?	36% (39)	64% (69)	8,33	0,004
Do you experience chill more often when you are alone?	65% (70)	35% (38)	9,48	0,002
Are you usually relaxed before you experience a chill?	63% (68)	37% (40)	7,26	0,007
Can you induce a chill willingly and/or arbitrarily?	26% (29)	73% (79)	23,15	≤0,001
Do you usually concentrate on the music before you experience a chill?	70% (76)	30% (32)	17,93	≤0,001
Do you experience chills while moving to music?	66% (71)	34% (37)	10,70	0,001
Do you also experience chills in larger groups (e.g. during a concert)?	78% (84)	22% (24)	33,33	≤0,001
Do you only experience chills during certain pieces of music?	48% (53)	48% (53)	0,00	1,000

x^2[FG=1]: Chi^2-value for one degree of freedom (df); p: significance

Table 2 shows the frequencies for the dichotomous Yes/No-questions regarding chill-sensations. According thereto chills are most commonly experienced alone, in a state of relaxation, while concentrating on the music, whereby 50% of participants state that it does not necessarily have to be a specific piece of music. Interestingly, as there are no respective empirical studies to date, 26% of participants claim to be able to willingly induce a

chill and 66% of persons also experience chills while moving (dancing) to music.

4.2.2 Basic dimensions of chill-sensations

After discarding problematic items (see 3.1) a first factor analysis lead to a 12-factor solution under the application of the Kaiser-1-criterion (selection only of factors with eigenvalues >1). These factors were, however, only comprised of an average of three to four items and were furthermore not sufficient regarding their content, wherefore a second criterion for factor extraction was applied, namely the trend of the eigenvalues (Scree-test, see Cattell, 1980). This test showed a marked change in the trend of eigenvalues after the fifth factor. We therefore reckoned every possible factor-solution from the twelve factors to a two-factor solution and compared the matrices of loadings regarding content and factor loadings. The result was that the five-factor solution showed the best results with 40% explained variance both regarding item loadings as well as content. Table 3 shows the item and scale statistics of the items selected through factor analysis. In addition to the five scales, all items regarding socio-emotional defense (SED), which were not represented within the five factors, were comprised into a further scale for future research.

The first scale consists of items dealing with positive mood and emotional relaxation and is therefore called »positive reactivity« (PoR). The second scale is made up of items regarding subjective physiological reactions and is called »physiological reactivity« (PhR). The items of the third scale address issues of motor reactions to chill-sensations. The construct was named »motor reactivity« (MoR). The fourth scale deals with social and cognitive processes and is therefore called »socio-cognitive reactivity« (ScR). The fifth scale is harder to interpret. It has certain similarities to the scale PhR, but also has items describing loss of bodily control. It was therefore called »disorientation« (Dis).

Table 3 shows that the five scales are sufficiently normally distributed and show satisfying reliabilities (α between 0.67 and 0.82). The highest α is found in the scales PoR and PhR, the lowest in the scale ScR. Apart from MoR and PhR the intercorrelations of the scales lie between r=0.20 and 0.41 ($p \leq 0,05$), wherefore it is justifiable to compose a collective scale. This has a mean of 60, standard deviation of 15.08 is also normally distributed (Kolmogorov-Smirnov-test: $p > 0,10$) and has an α of 0.83.

Table 3:
Results of scale constructions and reliability estimations

Scale		If I experience a chill or have experienced a chill, then …	M	SD	r_c
positive reactivity (PoR)		i25 I look positively into the future	1,81	1,17	0,55
A	0,82	i28 I feel to be in line with myself	2,19	1,11	0,63
M	12,37	i36 I feel fresh and recover	2,07	1,08	0,61
SD	4,92	i51 I am free from fears and worries	1,98	1,34	0,55
K-S	p > 0,1	i57 I feel somehow saved	1,80	1,07	0,60
		i64 I feel bodily relaxed	2,51	0,96	0,59
physiological reactivity (PhR)		i01 I get goose bumps	2,82	1,13	0,52
A	0,78	i10 my heart starts beating more quickly for a short time	2,02	1,14	0,51
M	13,58	i18 a frisson runs across my back	2,81	1,17	0,50
SD	4,92	i72 frequently I feel much warmer	1,84	1,18	0,50
K-S	p > 0,1	i71 I experience a comforting prickle at my body or certain body places	1,95	1,31	0,57
		i76 I feel like I am in love	2,14	1,23	0,52
motor reactivity (MoR)		i09 I turn the music louder	2,06	1,42	0,40
A	0,70	i12 I like to move to the music	1,89	1,32	0,67
M	13,13	i13 I feel somehow full of zest for action	2,01	1,29	0,37
SD	4,92	i16 I like to hum or sing along	2,60	1,21	0,35
K-S	p > 0,1	i32 I have the feeling that I would like to move my body	1,89	1,34	0,61
		i11 I interrupt my current activity for a short moment	2,45	1,21	0,22
social-cognitive reactivity (ScR)		i05 pictures are crossing my mind	2,19	1,15	0,36
A	0,67	i20 I would like to snuggle up to someone	1,67	1,16	0,36
M	10,81	i30 I remember past experiences and feelings	2,31	1,24	0,42
SD	4,41	i43 I have the feeling as if I would miss somebody	1,63	1,24	0,48
K-S	p > 0,1	i68 I like to help somebody who I am very close to	1,35	1,10	0,41
		i73 I think about my future	1,66	1,26	0,38
desorientation (Des)		i03 my mind is in a haze for a short moment	1,72	1,17	0,42
A	0,72	i04 I have the feeling as if tears well up my eyes	2,25	1,27	0,33
M	10,71	i14 I feel like my legs turn into jelly	1,96	1,29	0,48
SD	4,67	i17 for a moment I feel dazed	2,09	1,21	0,54
K-S	p > 0,1	i42 I feel excited and strained	1,44	1,19	0,36
		i48 I notice how my respiration changes	1,63	1,23	0,48
		i19 I become afraid of losing control	0,59	0,98	0,64
socio-emotional defense (SED)		i24 I wonder if I am still normal	0,61	1,12	0,59
A	0,85	i29 I attempt to fight against this feeling	0,51	0,99	0,65
M	3,70	i41 I notice that I am not myself for a moment	0,90	1,06	0,61
SD	4,70	i54 I am frightened of myself	0,46	0,84	0,76
K-S	p < 0,001	i61 I feel uncomfortably within my own body	0,52	1,04	0,60

M: mean; SD: standard deviation; rc: corrected item-total correlation; α: reliability estimation through Cronbach's Alpha (internal consistency); K-S: Kolmogorov-Smirnov-test for normality; p: significance of the K-S-test.

To test whether these five constructs are actually linked with the intensity of the subjective estimation of a chill-sensation, they were correlated with the results of the items »How intense would you estimate your personal chill-sensations?« and tested for differences with a one-way analysis of variance (ONEWAY ANOVA). It was shown that all five scales correlate significantly with the subjective estimation of chill-intensity ($p \leq 0.05$). This correlation can also be seen in the analysis of means (see diagram 3, which also shows the correlations): The higher the subjective estimation of chill-intensity, the higher the average value in the five scales ($p \leq 0.05$).

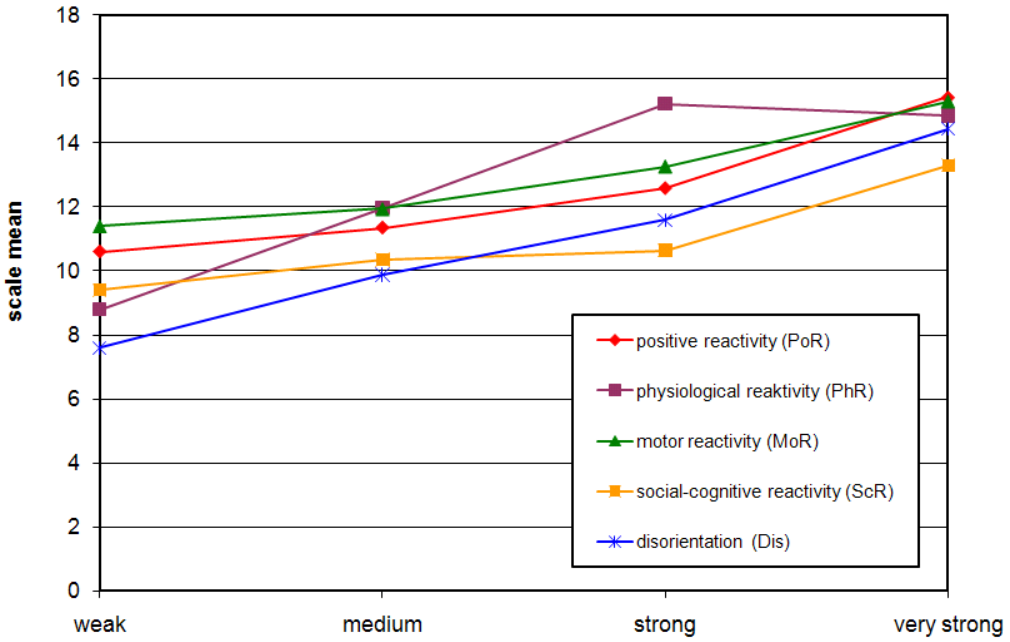

Diagramm 3: Means of the five scales within the category of the question »How intense would you estimate your personal chill-sensations?« (ONEWAY: $p \leq 0.05$). PoR: $r=0.26$ ($p=0.007$); PhR: $r=0.33$ ($p<0.001$); MoR: $r=0.22$ ($p=0.025$); ScR: $r=0.19$ ($p=0.05$); Dis: $r=0.36$ ($p<0.001$); SED (not shown): $r=0.05$ ($p=0.621$).

4.2.3 Individual differences

Table 4 shows the inter-correlations between the MRCQ-scales and the other measured personality dimensions. Firstly it becomes evident that the physiological reactions within chill-sensations are stronger in women than in men, whereas all other aspects shown no significant gender differences. Regarding individual differences on the basis of personality, table 4 shows that PoR is linked to low emotional instability (neuroticism), sociability (extraversion) and openness to experience. The latter also correlates with the MRCQ-scale disorientation (Dis) ($p \leq 0.05$). There is also a positive relation between ScR and conscientiousness. The trends of those correlations with a p-value of $p \leq 0.09$ may not be statistically significant, but show the contentual relevance of the MRCQ-scales (by enlarging the sample size, these correlations are likely to reach the threshold of $p=0.05$).

Table 4:
Inter-correlations between the MRCQ-scales and those of the NEO-ffi and the IAAM for the whole sample and separated according to gender

			Scales of subjective chill-sensations of the MRCQ					
Sample	**Variables**	**Scales**	PoR	PhR	MoR	ScR	Dis	SED
whole	NEO-ffi	N	-0,264 **	0,047	0,108	0,036	-0,047	0,021
		E	0,215 *	0,119	0,106	0,160 (*)	0,185 (*)	0,048
		OE	0,262 **	0,187 (*)	0,110	0,144	0,251 **	0,057
		A	0,104	0,134	-0,150	0,062	0,086	-0,059
		C	0,141	0,140	-0,015	0,220 *	0,159	-0,052
	IAAM	RX	0,421 ***	0,320 ***	0,385 ***	0,231 *	0,392 ***	0,181 (*)
		CP	0,212 *	0,277 **	0,263 **	0,302 **	0,227 *	0,176 (*)
		RA	0,127	0,259 **	0,347 ***	0,103	0,186 (*)	0,118
		FS	0,286 **	0,254 **	0,462 ***	0,154	0,245 *	0,133
		AM	0,239 *	0,170 (*)	0,346 ***	0,013	0,240 *	0,129
	gender		0,079	-0,242 *	-0.117	-0,138	-0,083	-0,130
	age		0,038	-0,118	-0,031	-0,135	-0,008	-0,007
women	NEO-ffi	N	-0,350 **	0,017	0,016	0,084	-0,065	0,186
		E	0,126	0,045	0,126	-0,059	0,132	0,098
		OE	0,094	0,115	0,023	-0,055	0,194	0,037
		A	-0,024	0,059	-0,172	-0,148	0,195	-0,021
		C	0,093	0,208 (*)	-0,078	0,058	0,203	0,033
	IAAM	RX	0,429 ***	0,262 *	0,377 **	0,163	0,385 ***	0,268 *
		CP	0,260 *	0,265 *	0,255 *	0,315 **	0,265 *	0,244 *
		RA	0,192	0,229 (*)	0,337 **	0,098	0,190	0,160
		FS	0,327 **	0,250 *	0,435 ***	0,096	0,207 (*)	0,136
		AM	0,340 **	0,172	0,479 ***	-0,003	0,255 *	0,061
	Alter		0,297 *	0,022	0,041	-0,089	0,161	-0,058
men	NEO-ffi	N	-0,059	-0,032	0,247	-0,116	-0,066	-0,127
		E	0,400 **	0,189	0,046	0,462 **	0,249	0,015
		O	0,546 ***	0,396 **	0,340 *	0,493 ***	0,370 *	0,042
		V	0,356 **	0,151	-0,182	0,290 (*)	-0,081	-0,058
		G	0,271 (*)	-0,038	0,019	0,372 *	0,078	-0,084
	IAAM	RX	0,450 **	0,374 *	0,377 *	0,316 *	0,393 **	0,117
		CP	0,191	0,180	0,219	0,218	0,129	0,189
		RA	0,063	0,195	0,323 *	0,035	0,146	0,150
		FS	0,269 (*)	0,179	0,496 ***	0,188	0,276 (*)	0,190
		AM	0,053	0,206	0,119	0,052	0,231	0,200
	Alter		-0,256	-0,201	-0,101	-0,281 (*)	-0,006	-0,127

PoR: Positive reactivity; PhR: Physiological reactivity; MoR: Motor reactivity; ScR: Socio-cognitive reactivity; Dis: Disorientation; SED: Socio-emotional defense; NEO-ffi: NEO-five factor inventory; N: Neuroticism (α=0.84); E: Extraversion (α=0.78); OE: Openness to experience (α=0.73); A: Agreeableness (α=0.73); C: Conscientiousness (α=0.88); IAAM: Inventory for the Assessment of activity and Arousal-modulation through Music: RX: Relaxation (α=0.89); CP: Cognitive problem solving (α=0.91); RA: Reduction of negative activation (α=0.92); FS: Fun stimulation (α=0.85); AM: Arousal modulation (α=0.85); gender: (0=female; 1=male); (n=108; women: n=66; men: n=42); (*): $p<0.09$; *: $p\leq0.05$; **: $p\leq0.01$; ***: $p\leq0.001$.

The relations between the MRCQ-scales and those of the IAAM are stronger, as the IAAM deals with habitual usage of music in everyday life as opposed to the NEO-ffi. It can be shown that PoR, PhR and Dis are linked to the application of music for relaxation (RX). Chills involving cognitive aspects (ScR) are related to using music for cognitive and emotional problem solving (CP). Interesting is also the positive connection between MoR and the IAAM-scale of positive stimulation through music (FS), as the latter is comprised of both positive affectivity and motor components.

To exclude the possibility of falsification of correlations through gender differences partial correlations under exclusion of gender were reckoned. There were no structural differences. This shows that gender has no influence as a co-variable, but does not solve the problem of the influence of different correlations within the gender groups. Therefore the means between the gender groups were analyzed for all scales with Student's t-test and all correlations were reckoned anew for each gender separately.

The t-tests showed significant differences between genders in the MRCQ-scale PhR ($t=2.572$; $df=106$; $p=0.011$), the NEO-ffi-scales N ($t=2.097$; $df=106$; $p=0.038$) and C ($t=2.138$; $df=106$; $p=0.035$) as well as the IAAM-scales CP ($t=2.544$; $df=106$; $p=0.012$) and RA ($t=2.425$; $df=106$; $p=0.017$). This shows that women have a higher physiological chill-reactivity, are more conscientious and emotionally instable and use music more for cognitive problem solving and for the reduction of negative activation.

The correlations show that in women positive chill-sensations are linked with low emotional instability, whereas in men with high values in extraversion and openness to experience. The latter is generally connected to all aspects of chill-sensation in men. Both genders showed a close connection between the capability of relaxing with music (RX) and chill-sensations, but the amount of statistically noticeable correlations between the remaining scales of the IAAM and those of the MRCQ is higher in women. This may indicate that in men personality is more important for chill-sensations, whereas in women the personality-dependent learned behavior to modulate emotions through music appears statistically more relevant.

4.2.4 Summary of study 2

Study 2 shows that there appear to be five dimensions of chill-sensations, that are psychometrically measurable. All constructed scales show good reliabilities regarding their low item numbers and are normally distributed. Although an orthogonal factor rotation was used, the independence of the chill-dimensions could not be established. The high inter-correlations be-

tween the scales suggest that it should be better to speak of facets of chill-sensations rather than of independent dimensions. Further analyses of individual differences and correlations with personality variables show marked gender differences, wherefore it can be assumed that men and women experience chills differently and that chills are linked to different clusters of variables. This emphasizes the necessity for the control of gender effects in experimental settings.

5. Discussion

First we should address some methodological points of critique, which are important for the discussion of results. The sample, albeit more heterogeneous than that of Grewe (2007), for example, is comprised primarily of students. It is not clear, whether there is a sample bias. This has to be established through further studies. This is also relevant for the identification of the different dimensions or facets of chill-sensations. Again further research is required to confirm, reassess or possibly discard the dimensions won through exploration (a study with n=200 is being evaluated at the moment). Another point of critique is the low value of the empirically resulting correlations, also in this study. It should be mentioned, however, that the statistical connections may not be of high practical value (in a sense of predicting the reactions of a person at a given point in time), but are essential for the generation and verification of underlying theories.

On a whole the study should be looked upon as a first attempt of a construct-psychological approach to chill-sensations. The results should therefore be interpreted carefully. In any case it seems necessary, despite the aforementioned constraints, to interpret the results in a theory-oriented fashion in order to generate hypotheses for future research.

Study 1 shows that chills are known to more persons than experimental studies lead to believe. This supports the works of Sloboda (1991) and shows that experimental research on chills may be a special case in which the exemplary music and the sample may be of high importance. Interesting is that chills are comprised of a high variation of reactions (whereby study 1 only showed the first nomination — the actual variation is therefore much higher). Chills, as a psychological phenomenon, are therefore much more variable than previously expected. This reaffirms the supposition that chills in experimental settings — especially due to the exposition with certain musical examples — are only a subtype of chill-sensations. The descriptive analysis also shows a result not discussed in literature: Contrary to the no-

tion that chills only last a few seconds, 28% of subjects state having experienced chills that lasted for 10 seconds and longer. This reaction is very strong in some persons and probably not inducible in a laboratory setting. It is also likely that these kinds of long and emotional chill-reactions might be avoided in social circumstances, e.g. during an experiment.

On the basis of these and other results from study 1, study 2 showed that chills can be measured as a whole construct, but also with different facets. According to the experimental research constructs were found regarding affectivity (PoR), physiological reactions (PhR) and motor activation (MoR), whereby women experience higher physiological reactions. Additionally we found constructs of socio-cognitive activation (ScR) and disorientation (Dis). While the socio-cognitive component is easily interpreted, the disorientation is somewhat problematic. Taking into account the positive inter-correlation within the males of the sample with openness to experience, however, it can be assumed that aspects of physical and psychological impulse control are involved herein. This would explain this facet sufficiently. The construct of socio-cognitive reactivity has not been overly scrutinized in past research. Apart from the activation of emotional memories of past experiences, as is commonly evoked through music, there also appear to be aspects of social binding-theory involved, whereby it is apparently unimportant whether there is a desire for approach or rather a feeling of loss. It can therefore be assumed that this facet is linked to the interpretation of chills as an old, rudimentary, binding-relevant signaling system (Panksepp/Bernatzky 2002). Taking into account that the dimension of positive experience is also measurable, which could be viewed as supportive of the interpretation of the results by Blood/Zatorre (2001), then it is assumable that we are not dealing with divergent theoretical approaches, but rather that both are valid. How strong individuals react positively during chills and/or show socio-cognitive tendencies needs further research.

The inter-correlations with the other used inventories (NEO-ffi and IAAM) show that, for the whole sample, high emotional stability (-N), sociability (+E) and openness to experience (+OE) are important predictors for chills. This supports the results of McCrae (2007), whereby OE is important for chills in various cultures, but also shows that other psychological constructs are linked to the subjective psychological representation of chills. Taking into account that sensation seeking is positively correlated to extraversion and negatively with neuroticism (Beauducel et al. 1999; García et al. 2005) and is also a predictor for openness to experience, then this study shows opposite relations between sensation seeking and chills compared to Grewe et al. (2007a, 2007b). There do, however, appear to be strong

gender differences. The inter-correlations suggest that emotional stability in women and extraversion and openness to experience in men are relevant for chill-sensations.

The capability of modulating emotions through music (IAAM) is also linked to chills, although this capability does not appear to be prerequisite for chill-sensations. It can be assumed that the biological disposition for the perception of strong music-related emotions promotes the learning of strategies for modulation of emotion through music (see von Georgi et al. 2006), but also coincides with heightened chill-sensations. The center of the usage of music is found in the IAAM-scale RX, the capability for relaxation through music. This dimension correlates highly in men and women with all facets of chill-sensations. It appears to be important that people are capable of inducing chill-beneficial moods through music. This may sound trivial, but has never been measured or controlled in previous studies (e.g. variations of the setting of measurement of the relaxation-capability).

Finally the relations of the NEO-ffi and IAAM to the chill-facets are based primarily on personality in men and on the capability of using music for emotional modulation in women. This could be indicative thereof that men experience chills more by chance and are overwhelmed by them, whereas women actively experience chills and include them in their appreciation of music. An ex-post-facto analysis of the item »Are you capable of willingly inducing and repeating chills?" showed no significant gender difference (x^2=0.103; df=1; p=0.748). It is therefore likely that men and women are only different in their subjective experiences, but not in their chill-related behavior.

Independently of these interpretations five facets of chill-sensations are psychometrically measureable and are dependent on personality. The advantage of such an inventory is the applicability both in experimental research and in surveys and qualitative and quantitative field studies. Hereby the importance of chills for subjective experience can be measured and resulting long-term behavioral consequences can be observed (e.g. music class, musical preference, assessment and aesthetical appraisal of music etc.). The pilot study at hand should therefore be understood as a first step in a new direction.[2]

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