RELATIONS BETWEEN TEMPO PERFORMANCE, EXPRESSIVENESS, AND MUSIC THERAPY OUTCOME

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ABSTRACT

Background. Patients with chronic pain disease suffer from "inhibited expressiveness" (e.g. high muscle tonus, inflexible mimic and gesture). The "Heidelberg Model" for music therapy with pain patients focuses on emotional flexibilisation and enhancement of expressiveness through musical flexibilisation. Inhibited expressiveness should especially affect patients' musical performance regarding tempo and timing, which are important parameters for expressive music performance.

Aim. Music therapy claims that musical performance mirrors psychological aspects of subjects. Positive correlations between tempo performance, expressiveness, and therapy outcome would support the claim.

Method. A controlled experimental study with 16 pain patients receiving music therapy, 21 pain patients without music therapy, and 30 healthy subjects is conducted. Psychological questionnaires measure expressiveness, therapy outcome, pain intensity, and affective pain perception pre, interim, and post 20 music therapy sessions. Flexibility in musical tempo performance is tested with subjects synchronising on an electronic drum to a musical stimulus which changes in tempo. Test design also includes tapping tasks.

Results. Results for pain patients with music therapy are presented. Self perception of expressiveness seems a weak indicator for inhibited expressiveness. Expressiveness scores and tempo performance differ with regard to therapy success and musical training. Therapeutic success as well as tempo performance are both positively correlated to expressiveness. Subjective tapping tempo and regularity are related to tempo performance.

Conclusion. For the treatment of chronic pain disease, enhancing expressiveness through active music therapy seems to be effective. Psychological expressiveness is indeed reflected in tempo performance. Tempo and regularity of an "internal timekeeper" supposedly affect musical performance, which might have implications for music therapy.

1. INTRODUCTION

The study presented follows a music psychological approach to music therapy research focussing on tempo performance. The research is closely connected to a project at the German Centre for Music Therapy Research in Heidelberg, which examines the effectiveness of music therapy in the treatment of chronic pain patients (Hillecke 2002).

Psychological factors are assumed to play a crucial role in developing chronic pain disease, like headache or back pain. Traue (1998) showed that patients suffering from chronic pain have a high muscle tonus without realising it. Traue also observed discrepancies between physiological reactions, verbal expressions, and mimic-gesture behaviour. This psycho-physiological state of pain patients is called "inhibited expressiveness" whereby high muscle tonus might serve to suppress emotional involvement (Traue et al. 2000). Chronification of pain is accompanied by an increase of introversion (Phillips and Gatchel 2000) and chronic pain patients are described to have limited expressive abilities and to suffer from "emotional inflexibility" (Bolay et al. 1998). Accordingly, the "Heidelberg Model" for music therapeutic treatment of chronic pain focuses on enhancing expressiveness and emotional flexibility through musical flexibilisation (Hillecke and Bolay 2000). Music therapists described musical performances of pain patients as inflexible (small melodic and dynamic range, same instruments) with variations in tempo being particularly difficult.

Tempo and timing are important parameters in expressive music performance. Research on musical motion and gesture has shown that concrete timing structures of musical accelerandi and ritardandi resemble timing structures of physical movements, like slowing down from running, and that listeners prefer those musical timing structures (Kronman and Sundberg 1987; Repp 1992). Todd (1992) suggested that certain musical timing structures do not only lead to associations with physical motions but induce a sense of self-motion. Accordingly, motion and gesture in music can be called "a truly perceptual phenomenon" (Clarke 2001) and not just a metaphorical expression. For pain patients who are suffering from high muscle tonus and an inability to express emotions adequately through gesture, mimic, and verbal communication, it seems plausible that the inhibited expressiveness affects their musical performance, in particular aspects of tempo and timing.

2. QUESTIONS

The aim of the study is to test whether patients with chronic pain perceive themselves as less expressive than healthy subjects and to test their musical abilities to flexibly respond to changes in tempo. The study questions whether expressiveness and tempo performance improve during the course of music therapy, how both are related, and what effect therapeutic success and musical training have. The main hypothesis is that expressiveness and tempo performance are positively correlated: the higher the expressiveness, the better the flexible tempo performance.

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3. EXPERIMENT

3.1. Subject Groups

Clinical groups. The study was conducted with 37 patients suffering from different kinds of benign chronic pain. 21 of these patients (14 female; age: 53.3 ±8.9) received only medical treatment at the Pain Centre of the University Hospital of Heidelberg, while 16 patients (13 female; age: 52.9 ±10.7) were given additional music therapy at the Music Therapy Outpatient Department of the University of Applied Sciences Heidelberg. The music therapy followed the "Heidelberg Model" (emotional flexibilisation through musical flexibilisation). Patients were treated in 20 individual sessions and tested 3 times on psychological questionnaires and on tempo performance: pre, interim, and post therapy. The group with only medical treatment answered the psychological questionnaires once and performed the tempo test twice.

Non-clinical group. 30 subjects without medical conditions and therefore without medical or music therapeutic treatment (25 female; age: 50.7 ±18.1) were tested on psychological questionnaires once and on tempo performance twice.

3.2. Method of Assessment

Psychological questionnaires. The German version of the "Outcome Questionnaire" (OQ-45.2) measures co-morbid psychological symptoms (general therapy outcome). Pain intensity is assessed using a visual analogue scale from 0 to 10 (VAS), and affective dimensions of pain are measured on the "Pain Perception Scale" (SES). For the measurement of expressive behaviour German versions of the "Affective Communication Test" (FEX, Traue 1998), the "Inventory of Interpersonal Problems" (IIP, subscales "being too introvert" and "being too expressive"), and the "Freiburg Personality Inventory" (FPI, subscales "inhibition" and "extraversion") were used.

Test on tempo performance. The standardised musical stimulus (duration 220 sec) consists of 35 sections of different tempi (50 to 200 beats per minute (bpm)) and durations (10, 5, or 3 sec). The measure of 4 quarters per bar is accented. In addition to quarters, eight notes are performed leading to an inner tempo (rhythmic activity) range of 60 to 252 onsets per minute (opm). The stimulus was realised as vibraphone sound and presented via headphones. Subjects were asked to drum along with the music on the MIDI-pads of an electronic hand percussion instrument[1] using both hands. The musical performance of the subjects was reproduced via headphones as conga sound and recorded as Standard MIDI-File.

Tapping tasks. Subjects tap as regularly as possible with the middle finger of their dominant hand for 30 sec on a MIDI-pad: a. in their preferred tempo (subjective tapping) and b. as fast as they can (maximum tapping). The tappings were recorded and analysed according to mean tempo (median of inter-onset-intervals (IOI)) and regularity (standard deviation of IOI).

3.3. Method of Analysis

Analysis is conducted using the statistic software SPSS. Group differences are calculated by t-test. Relations between different measures are tested using correlation analysis by Pearson as well as rank correlation analysis by Kendall.

Musical measures. The developed musical measures can be categorised either whether they are based on the general frequency of onsets per tempo section or whether they take the exact onset time into account. The exception is "Intensity" which indicates the mean velocity value of subjects' drumming onsets.

Measures based on onset frequency**:** "OnsetFit" calculates the correlation (Pearson) between the number of stimulus onsets and the number of subjects' onsets at each of the 35 tempo sections. "Range" shows within which tempo span (maximum bpm / minimum bpm) subjects realise their performances. "TempoFit" quantifies a. how many of subjects' tempi fall within ±10% of the metronome tempi of the stimulus (mTF, based on bpm) and b. how many tempi fall within ±10% of the inner tempi of the stimulus (iTF, based on opm).

Measures based on onset time: "Synchronisation" uses cross-correlation analysis to quantify how well subjects synchronise with the stimulus. "Inner Structure" measures the internal structure of subjects' performances using auto-correlation analysis.

3.4. Results

Psychological expressiveness. Differences in self-assessed expressiveness between pain patients and healthy subjects are smaller than expected. Even though 70% of the patients' FEX-scores lie below the cut-off value of clinical significance (65.35, Melcher 2002), the mean difference to healthy subjects is not significant (t=–1.183, p=.241). Similarly, on the IIP-scale "being too introvert" pain patients score higher only with eye-evidence (t=1.356, p=.180). Whereas the IIP-scale "being too extrovert" as well as the FPI-scales "inhibition" and "extraversion" show no group differences.

The following analyses include only the 16 patients with music therapy.

Therapeutic success and expressiveness. To determine whether patients had successful music therapeutic treatment, Hillecke's (2002) criteria of therapy success were applied. They imply reliable improvements on at least one of the following scales and no deterioration: general psychological functioning (OQ), affective pain perception (SES), and pain intensity (VAS). According to these criteria 11 of the 16 patients had a successful music therapy (success rate 69%).

One aim of the "Heidelberg Model" is enhancement of expressiveness. Figure 1 shows the differences on the expressiveness questionnaire FEX pre and post therapy for patients grouped by therapy success. While 4 of the 5 patients

[1] I would like to thank Roland Elektronische Musikinstrumente GmbH, Norderstedt for their support of the research by providing the Handsonic HPD-15, an electronic hand percussion instrument.

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without therapy success perceive themselves as less expressive post therapy, the majority of patients with successful therapy improve their expressiveness scores. Therapy success and pre-post differences in expressiveness are positively correlated (r=0.569, p=.021).

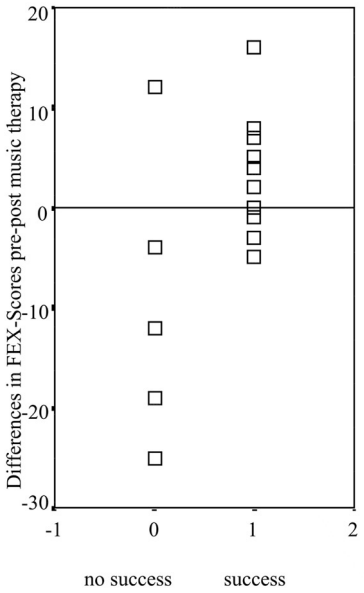

Figure 1: Differences between expressiveness scores (FEX) pre and post therapy grouped by therapeutic success.

Unexpectedly, patients with successful therapy have significantly lower FEX-scores in the pre test than patients without therapy success (t=–2.280, p=.039). On the other hand patients with some kind of musical training (n=8) show a tendency towards higher FEX-scores than patients without any musical training (n=8) (pre: t=1.816, p=.091; post: t=1.841, p=.087). Thus, an explanation for the differences in expressiveness between the success groups could be that 3 of the 5 patients without therapy success have experienced musical training.

Tempo performance. Generally speaking, on almost all musical measures patients score higher post therapy than pre therapy (constant exception: metronome TempoFit). But only 4 pre-post comparisons are statistically relevant. Range (t=–1.985, p=.066) and Intensity (t=–2.067, p=.056) increase with statistical tendency, while significant changes occur at TempoFit as figure 2 shows. The decrease in metronome TempoFit (mTF, t=2.361, p=.032) corresponds to an increase in inner TempoFit (iTF, t=–2.677, p=.017). These results indicate that patients pre therapy orient their drumming performance mainly on the beats (metronome tempo) of the musical stimulus, while post therapy they increasingly mirror its rhythmic activity (inner tempo).

With the exception of OnsetFit and Range, patients with successful therapy reach higher musical scores than patients without therapy success. But these differences only show statistical tendencies on inner TempoFit (pre: t=2.040, p=.061) and Intensity (post: t=1.897, p=.080). Differentiated according to musical training, patients with some kind of musical training score higher on nearly all musical measures, but group differences are only significant for inner TempoFit (post: t=3.046, p=.009) and Intensity (pre: t=2.690, p=.018).

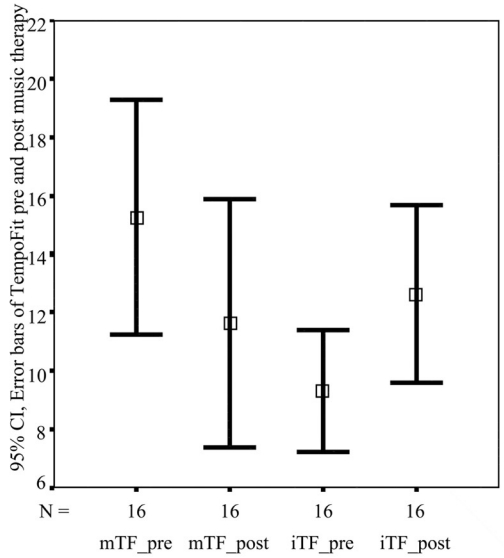

Figure 2: Error bars of musical measures metronome TempoFit (mTF) and inner TempoFit (iTF) pre and post therapy.

Tempo performance and expressiveness. Rank correlation analyses (Kendall) between musical and psychological measures reveal numerous correlations of statistical relevance. In sum, the psychological measures FEX, "extraversion" (FPI), and "being too expressive" (IIP) correlate positively with the musical measures OnsetFit, Range, inner TempoFit, and Intensity, while they show negative correlations to metronome TempoFit. The psychological measures "inhibition" (FPI) and "being too introvert" (IIP) correlate negatively with OnsetFit, Range, inner TempoFit, and Intensity. Thus, patients with higher expressiveness scores are more likely to set stronger onsets, to show a broader range of metronome tempi, and to successfully respond to the rhythmical structure of the musical stimulus, whereas less expressive patients rather focus on the metronome tempo. Most significant correlations are found either within the group of therapy success or the group of musical training. Interestingly, only few significant correlations occur for Synchronisation and Inner Structure, which analyse the musical performance according to timing aspects. Rare significant correlations between these timing measures and expressiveness scores (FEX and "extraversion" (FPI)) are negative.

Tempo performance and tapping. Finally, relations between tempo performance and tapping task were found. Figure 3 indicates that patients with lower subjective tapping tempi tend to synchronise best at lower stimulus tempi (Pearson, r=.447, p=.062). Further correlation showed: the less regular patients tap, the lower are their tempi of best Inner Structure (r=–.617, p=.011) and of best Intensity (r=–.544, p=.029). Detailed analysis will have to show whether these results are mainly caused by using mean values for these calculations.

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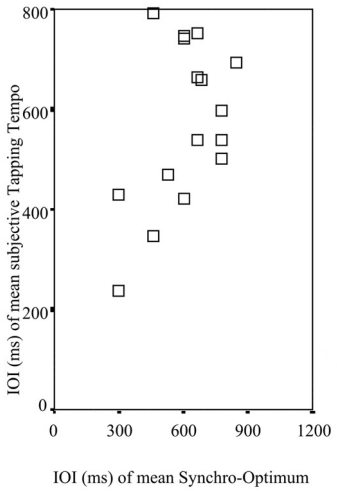

Figure 3: Mean subjective tapping tempo of 3 tests of music therapy group plotted against stimulus tempi of their mean Synchronisation optimum.

4. CONCLUSION

The study has shown that self perception of expressiveness only gives rather weak indications for "inhibited expressiveness" as a key characteristic of patients with chronic pain disease. Nevertheless, self-assessed expressiveness scores are found to vary depending on music therapy success. While successful music therapy relates to enhancement of expressiveness, unsuccessful therapy relates to lowering of expressiveness scores. Though it has not yet been analysed how many changes in expressiveness are reliable and clinically significant, it does not seem apparent that music therapy should at all lead to deterioration in expressiveness. Music therapists suggested that music therapy most probably helped to establish a more realistic self perception. Thus, even the lowering of expressiveness could be seen as a kind of therapeutic success. During the course of music therapy performance on the musical tempo experiment generally improved. This could not simply be due to habituation to the experimental setting and to learning effect, because therapeutic success and musical training account for some differences in tempo performance. Higher expressiveness relates to adaptation of the rhythmical structure of the stimulus, whereas lower expressiveness relates to orientation on the metronome tempo. According to the hypothesis, psychological parameters could be positively correlated to musical parameters. Hence, psychological aspects of expressiveness are indeed mirrored in musical tempo performance: the more expressive, the better the tempo performance. Thus, the aim of active music therapy to induce psychological changes through changes in musical behaviour appears attainable. But those positive correlations mainly involve the more general musical measures based on onset frequency (tempo), while musical timing aspects barely relate to expressiveness, if so negatively. This could be an indication that higher expressiveness might help to respond more flexibly to changes in tempo, but does not help (or even hinders) to precisely synchronise with different tempi and to establish exact periodicities. That the simple motor task of finger tapping is at all related to the tempo performance might suggest that tempo and regularity of a supposed "inner timekeeper" influence musical performance. Therefore, taking the "inner tempo" of a patient as a starting point for music therapeutic improvisations might support successful musical communication.

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