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Enhancing improvisational music therapy through the addition of resonance frequency breathing: Common findings of three single-case experimental studies

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Abstract

One core characteristic of active music therapy is the facilitation of emotional expression through the creation of music improvisations. In an attempt to further develop this approach, we created an enhanced form of integrative improvisational music therapy by including 10 minutes of resonance frequency breathing (RFB) at the beginning of the sessions. RFB is a type of slow-breathing known for its ability to reduce stress and support emotional regulation. This paper summarizes the common findings of three single-case experimental studies and introduces a provisional model to explain the observed effects of RFB. During the breathing itself, all three clients (two of them healthy and one diagnosed with anxiety disorder) displayed significantly higher relaxation levels compared to the control intervention, as seen through their level of heart rate variability (HRV), a measure of autonomic nervous system response. We also found an association between RFB and the high frequency HRV component (HFnu) during music-making, with the two healthy clients presenting lower HFnu after RFB, whereas the opposite was true for the diagnosed client. Lastly, talking and music-making proved to be two very different activities in terms of HRV, each client perceiving one of them as systematically more stressful than the other. RFB appears to be an adaptive intervention providing either emotional upregulation or downregulation depending on the client's needs, while keeping arousal levels inside the window of tolerance. Between-group studies would be required to determine whether the addition of RFB also leads to better therapeutic outcomes.

Keywords:

improvisational music therapy; resonance frequency breathing; emotional regulation; heart rate variability; process measures.

Introduction

Because of the intrinsic ability of music to elicit and express emotions, emotional processes can rightly be considered the core element behind the dynamics of change within music therapy (Pellitteri, 2009). This is especially true in improvisational music therapy, whose specificity is to offer an alternative to verbal communication by allowing clients to express difficult or repressed emotions through musical improvisations (MacDonald & Wilson, 2014). In that sense, improvisational music therapy belongs to the larger family of experiential, emotion-focused, and psychodynamic therapy methods.

We already know from existing research that the facilitation of a client's emotional experience and expression is connected to more positive outcomes in therapeutic approaches based on psychodynamic principles (Diener, Hilsenroth, & Weinberger, 2007). One general and recurrent finding in the psychotherapy literature is that clients who face and process their emotions more—especially during mid-therapy—will also improve more (Greenberg & Pascual-Leone, 2006; Missirlian, Toukmanian, Warwar, & Greenberg, 2005; Watson & Bedard, 2006). It logically follows that whatever a therapist can do to facilitate constructive emotional processing represents a therapy enhancement that should lead to a better outcome.

Building on this idea, we developed a new therapeutic approach wherein clients start their session of improvisational music therapy with 10 minutes of a slow-breathing intervention known as resonance frequency breathing (RFB). This breathing intervention has been specifically chosen for its known ability to support emotional regulation by instantly and reliably reducing stress levels (Goessl, Curtiss, & Hofmann, 2017). However, since RFB is typically used as a stand-alone intervention, no prior knowledge was available regarding its effects when used as a preparatory intervention within psychotherapy or music therapy. We therefore decided to conduct three exploratory studies to investigate the possible benefits of combining RFB and improvisational music therapy.

The aim of this article is to present the common findings of these three exploratory studies and offer a tentative model to explain the results. More specifically, we wanted to answer the following two research questions. RQ1: Does RFB used as a session prelude have any measurable effects on emotional processes and stress levels during improvisational music therapy? RQ2: To what extent are any observed changes associated with RFB therapeutically useful and relevant?

Key Concepts

Heart rate variability and health

Our heart rate is never constant, but fluctuates on a beat-to-beat basis. The magnitude of this

fluctuation is known as heart rate variability (HRV). HRV is the result of the interplay between the two branches that constitute the autonomic nervous system (ANS), namely the sympathetic (fight-or-flight) and parasympathetic (rest-and-digest) branch (McCorry, 2007). Typically, stress and anxiety are accompanied by an increased influence of the sympathetic branch, leading to reduced levels of HRV. Conversely, when a person feels calm, happy, and relaxed, the parasympathetic branch is dominant, which translates into an increase in HRV (Shaffer, McCraty, & Zerr, 2014).

A person's capacity for emotional regulation is directly dependent on the flexibility of the ANS and the way it responds to changing situational demands (Appelhans & Luecken, 2006). Among other things, a more resilient ANS means higher HRV at rest (Fabes & Eisenberg, 1997), shorter recovery time from stress (Weber et al., 2010), and greater social well-being (Kok & Fredrickson, 2010). Generally speaking, when considering HRV, high values are always more desirable than low values. Indeed, medical research has established that reduced HRV is connected to an increased risk of disease and all-cause mortality (Dekker et al., 2000). In particular, low HRV serves as a good predictor for cardiovascular diseases and cardiac events (Tsuji et al., 1996). On the psychological level, reduced HRV has been shown to accompany emotional disorders such as panic disorder, post-traumatic stress disorder, anxiety disorders, and depression (Alvares, Quintana, Hickie, & Guastella, 2016).

The role of respiration

Breathing interventions have an effect on autonomic arousal because of the intimate connection that exists between heart rate and respiration, whereby heart rate increases during inhalation and decreases during exhalation. This natural variation in heart rate that accompanies breathing is called respiratory sinus arrhythmia, and its intensity is proportional to the amount of parasympathetic activity (Appelhans & Luecken, 2006). The existence of this cardiorespiratory coupling means that we can directly influence our heart rate through our breathing pattern, which will consequently affect our emotional state and level of arousal.

In other words, any breathing intervention able to increase respiratory sinus arrhythmia will automatically make the ANS shift towards parasympathetic dominance, resulting in increased calmness and positivity. This effect on autonomic functioning is well-known and has been observed with numerous techniques employing deep and slow breathing, for example pranayama yoga (Jerath, Edry, Barnes, & Jerath, 2006; Pal, Velkumary, & Madanmohan, 2004). Moreover, it should be noted that breathing interventions have become increasingly common for the treatment of various psychological and stress-related disorders (for an overview, see Brown, Gerbarg, & Muench, 2013).

Resonance frequency breathing

Research into cardiorespiratory coupling has demonstrated that for each person there exists an

optimal breathing speed where the amplitude of heart rate oscillations is maximized (Vaschillo, Lehrer, Rishe, & Konstantinov, 2002). Typically, this maximization of HRV is achieved at around 6 breaths per minute. When plotting the corresponding heart rate pattern (with time on the X-axis and heart rate on the Y-axis), we obtain a very smooth, high-amplitude curve resembling a sine wave. In comparison, the heart rate curve during normal breathing tends to be more chaotic and jagged, with a much lower amplitude. To illustrate this difference, Figure 1 shows the heart rate curve of the same client under two different breathing conditions (10 min of RFB vs. 10 min of relaxation with normal breathing).

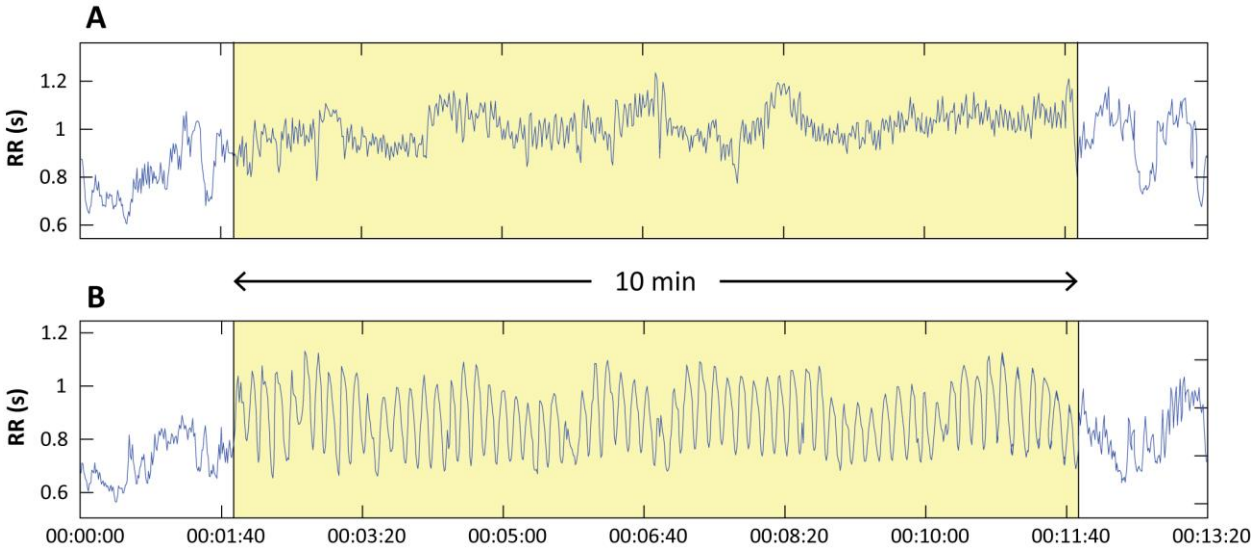

Figure 1. Example of heart rate (RR intervals) during normal breathing (A) and RFB (B).

Besides the maximization of HRV, another physiological effect of RFB is to synchronize heart, respiratory, and blood pressure rhythms. The specific breathing rate or frequency that produces this combined amplification and synchronization effect is known as the "resonance frequency." When an oscillatory system is rhythmically stimulated at the system's resonance frequency, the oscillations are not only maintained but also amplified, hence the name of the breathing method. One useful property of this resonance frequency is that it remains stable in adults, the main influencing factors being body height and blood volume. Age and weight, for example, do not seem to influence it, nor does prolonged practice of RFB (Lehrer & Gevirtz, 2014).

RFB is generally considered a safe intervention with no known risks or contraindications (Eddie, Vaschillo, Vaschillo, & Lehrer, 2015). The only issue that might arise while performing RFB is hyperventilation, recognizable by feelings of dizziness. Indeed, when people are asked to breathe more slowly, they often tend to breathe deeper, causing a drop in the level of carbon dioxide in the blood. This is why it is important to tell clients not to breathe too deeply and to breathe more shallowly should they notice any sign of hyperventilation.

Since its introduction in the 1990s, RFB and its more elaborate implementation in the form of heart rate variability biofeedback have been successfully applied to treat a wide range of health conditions, from physical disorders such as asthma and chronic muscle pain, to psychological disorders such as anxiety and depression (for an overview, see Gevirtz, 2013). However, as mentioned above, these applications usually involved using RFB in isolation or as a complement to standard care, without attempting to combine it synergistically with another therapy method. One exception is a recent study where a form of breathing biofeedback similar to RFB was integrated into trauma-focused cognitive behavioral therapy (TF-CBT), and compared to TF-CBT without biofeedback (Polak, Witteveen, Denys, & Olff, 2015). The authors hypothesized that the breathing intervention might help clients better handle the stress increases during the exposure parts, resulting in larger symptom reduction. Although the outcome was in fact similar in both groups, the biofeedback group displayed faster symptom reduction, which suggests that the addition of the breathing intervention may represent an improvement over TF-CBT alone.

Improvisational music therapy

Music therapy is a broad and versatile field encompassing many different approaches and models. The methods most regularly used are improvising, composing, performing, music listening, and verbalization. Improvisational music therapy refers to approaches that rely essentially on the creation of music improvisations together with the therapist (Bruscia, 1987). As opposed to improvisations played by trained musicians as part of a specific genre, improvisations in music therapy do not necessarily result in “proper” music, since the focus is more on the creation process, with an emphasis on spontaneity and self-expression.

Most of the differences between the existing models of improvisational music therapy derive from the clinical setting and the client population for which they were designed. For instance, some are meant to be used on a one-on-one basis with children presenting developmental disorders (James et al., 2015), while others are designed for group therapy with normally-functioning adults (Skewes, 2002). However, because of their inherent flexibility, most models can easily be adapted to different clients and contexts. In practice, all the models for individual therapy use a common set of techniques and activities, categorized by Wigram (2004) as follows: mirroring, matching, empathic confirmation or reflection, stabilization (grounding, holding, and containing), dialoguing, modeling, and accompanying.

In terms of health-promoting mechanisms, MacDonald and Wilson (2014) identified four unique characteristics of music improvisations: 1) the ability to facilitate the emergence of unconscious material, 2) the provision of an absorbing and creative experience unfolding in the present, 3) the interactive and social nature of the process, and 4) the possibility to express emotions in a non-verbal way. These characteristics are thought to be largely responsible for the

positive results obtained with improvisational music therapy in the treatment of clients experiencing neurological damage, emotional disorders, and developmental disorders involving communication difficulties (MacDonald & Wilson, 2014).

The specific model used in our three exploratory studies was integrative improvisational music therapy (IIMT). IIMT is mainly informed by psychodynamic theories, but it also contains elements borrowed from supportive psychotherapy and resource-oriented approaches (Erkkilä, Ala-Ruona, Punkanen, & Fachner, 2012). So far, it has mainly been used for individual therapy with adults presenting with emotional disorders. Similar to other improvisational models, IIMT does not require the client to possess any particular music training. The only prerequisites are the capacity for abstract thinking and the presence of sufficient language skills to discuss the improvisations.

In a nutshell, IIMT encourages clients to express themselves musically through the creation of free improvisations together with the therapist. These improvisations and their related themes, emotions, and associations are then discussed verbally. The alternation between musical and verbal moments is seen as the key element behind the therapeutic benefits derived from IIMT. In terms of effectiveness, a previous randomized controlled trial has shown that IIMT was more effective than standard care alone in the treatment of depression and co-morbid anxiety, with higher response rates in the IIMT group and effects that were clinically significant (Erkkilä et al., 2011).

Method

Our three consecutive studies were focused on developing and testing a new therapeutic concept, with each study capitalizing on the findings of the previous one(s). They were thus exploratory in nature and conducted with a certain degree of variation, mainly with regard to the control intervention, the type of client, and the assessment instruments. However, as we will see in the following sections, they presented enough methodological consistency and overlap to warrant a juxtaposition of their results.

Design

Each study was a single-case experimental study following an alternating treatments design (Byiers, Reichle, & Symons, 2012). All the sessions, across the three studies, had the same structure. They started with 10 minutes of a preparatory intervention (RFB or control) followed by 45 minutes of IIMT. Furthermore, the experimental conditions (RFB or control) were systematically alternated (ABABAB...). In this type of research design, participants serve as their own control and causal inferences can be made if a change in the experimental condition is systematically accompanied by a clear and consistent change in the dependent variables (Shadish, Cook, & Campbell, 2002). The only differences in terms of structure were the control

intervention used, the order of the conditions, and the overall length of the therapy processes. In Study 1, music-listening was the control intervention, whereas vibroacoustic therapy (VAT) was used in Study 2 and 3. Although different in nature, the two control interventions were chosen for their ability to provide relaxation, making them suitable alternatives to RFB. Regarding the conditions' alternation, Study 1 began with RFB in the first session, while Study 2 and 3 began with the control intervention. As to the overall length, Study 1, 2, and 3 comprised 10, 18, and 12 sessions respectively.

Despite this difference in length, there were enough observations in each condition to meet the standards for single-case research designs identified by What Works Clearinghouse, whereby a minimum of five repetitions of the alternating sequence are required (Kratochwill et al., 2010). Besides, since each study comprised an even number of sessions, the total number of sessions in each condition was always balanced.

Generally speaking, the reason why we decided to test RFB against an active control intervention was threefold. First, we did not want to keep the client idle for 10 minutes. Second, to keep the session structure consistent, we wanted these preliminary 10 minutes to always be about relaxation, whatever the experimental condition. Third, offering a credible alternative to RFB made it possible to present all the preparatory interventions as having the same purpose (relaxation), thus minimizing the risk of the clients having divergent expectations.

Matching the expectation levels between treatment and control is an aspect often neglected in intervention research. In its absence, placebo effects are not sufficiently controlled for, which reduces the confidence in any causal efficacy attributable to the treatment (Boot, Simons, Stothart, & Stutts, 2013). Although the choice of adequate controls is especially crucial in treatment efficacy studies and systematic reviews (Karlsson & Bergmark, 2015), applying this principle to our single-case exploratory studies can only strengthen their internal validity.

Participants

The three participants (called henceforth Client 1, 2, and 3) were young females in their 20s or 30s. Client 1 and 2 had no diagnosis or major mental health issues, while Client 3 was diagnosed with anxiety disorder and social phobia. The clients also differed in terms of cultural background, with Client 1 and 3 being of European background and Client 2 of Chinese background. Client 1 and 2 were recruited among the students of the University of Jyväskylä, Finland, while Client 3 was referred to the research project by a local psychotherapist familiar with music therapy. All the clients agreed to the terms of the study and signed an informed consent form stipulating that the therapy sessions would be filmed and the collected data used for research purposes. The studies fully complied with the ethical guidelines of the University of Jyväskylä that were in place at the time of the data collection.

Setting

The therapy sessions took place on a weekly basis at the University of Jyväskylä, Finland, in the music therapy clinic of the Department of Music, Art and Culture Studies. The music therapy clinic is equipped with various analogue and digital music instruments, as well as with non-intrusive microphones and video cameras. The three therapy processes were conducted by three different therapists, all of whom were in the final year of the Master's Degree Program in Music Therapy offered at the University of Jyväskylä. Being part of the same program, they all received the same training in clinical improvisation techniques, as well as in the principles and methods of the IIMT model.

Procedure

RFB was performed in the same way across all three studies. Before the beginning of the therapy process, we met each client individually and conducted a breathing assessment to determine their resonance frequency. This was done by testing six different breathing speeds ranging from 7 to 4.5 breaths/min, in accordance with the iteration method described by Lehrer (2007). An optimal breathing speed is understood to be the one that produces the highest level of HRV, as established through power spectral analysis of the heart rate signal.

After having determined each client's optimal breathing speed, we used that information to provide individualized breathing cues in the sessions starting with RFB. The breathing cues were given by a breathing app running on an Android tablet that the client would hold in front of her while sitting in an upright position. In addition to being set to the correct breathing speed, the app would deliver visual and auditory cues at an inhalation/exhalation (i/e) ratio of 40/60—meaning that exhalations lasted longer than inhalations. This aspect is important because low i/e ratios have been shown to induce higher HRV levels than high i/e ratios (Diest et al., 2014).

Vibroacoustic therapy (VAT) is an intervention that consists of the application of low-frequency sound waves onto the body through speakers placed inside an armchair or mattress (Punkanen & Ala-Ruona, 2012). VAT is often used as a stand-alone intervention to treat pain, muscle spasticity, stress, and anxiety (Grocke & Wigram, 2007). We administered VAT with the help of a Next Wave Physioacoustic PRO therapy chair. This apparatus received 510(k) clearance from the U.S. Food and Drug Administration as a class II medical device (clearance number: K905256). In the two cases involving VAT (Study 2 and 3), we used the same pre-existing relaxation program for 10 min.

As to the music-listening intervention used in Study 1, it consisted of listening to 10 minutes of new-age style relaxation music while counting one's breaths in groups of four. Similar to VAT, we chose this intervention because targeted music listening is known to relieve stress and anxiety, both in healthy participants (Gäbel, Garrido, Koenig, Hillecke, & Warth, 2017) and

patients waiting to be hospitalized (Hamel, 2001).

Every time a preparatory intervention was being administered (RFB, VAT, or music-listening), the therapist sat next to the client in silence in order to monitor the client but not interfere with the intervention. Furthermore, it should be noted that VAT and music-listening did not involve any targeted manipulation of the breathing pattern. Instead, we encouraged the clients to breathe normally.

In accordance with the IIMT model, the music therapy component of each session consisted of verbal phases alternating with music improvisation phases. All the improvisations were performed either on a West-African djembe drum or a malletKAT Pro. The malletKAT Pro is a pressure-sensitive MIDI controller with the same key layout as a marimba, and it is played using one or two mallets. It also features a sustain pedal that functions like the sustain pedals typically found on pianos. In IIMT, client and therapist are facing each other during improvisations and will generally play together using the same type of instrument. This enables the therapist to more effectively mirror, ground, accompany, or challenge the client, depending on the clinical technique chosen by the therapist.

Measures

The cases were compared from the point of view of HRV, as heart rate data were the only type of data collected and analyzed in a similar way in all three participants. We reported elsewhere on the video analysis, session transcript analysis, and music feature extraction used in Study 1 (Brabant, Solati, Letulė, Liarmakopoulou, & Erkkilä, 2017), and the session evaluation questionnaire used in Study 3 (Brabant, van de Ree, & Erkkilä, 2017).

Beat-to-beat intervals were collected using a Suunto Smart Belt, which is a chest strap monitor that has been shown to be reliable when compared to regular electrocardiogram systems (Bouillod, Cassirame, Bousson, Sagawa, & Tordi, 2015). The Smart Belt functions completely autonomously, in the sense that it can store beat-to-beat intervals in its internal memory instead of having to transmit them to an external receiver. This eliminates the risk of data loss because of transmission problems. The clients were wearing a Smart Belt in each session, for the entire duration of the session.

Data processing and analysis were performed with Kubios HRV (version 2.2), an advanced software for HRV analysis (Tarvainen, Niskanen, Lipponen, Ranta-aho, & Karjalainen, 2014). Data were first pre-processed. This consisted of systematic artifact removal and detrending. Time and frequency domains were then analyzed. For interested readers, a more detailed description of the HRV methodology can be found elsewhere (Brabant, Solati, et al., 2017).

Regarding the choice of HRV indices, we based our study comparison on the following

metrics: RMSSD (the root mean square of successive beat-to-beat interval differences), HF (high frequency; the spectral power of the high-frequency component responsible for HRV), LF (low frequency; the spectral power of the low-frequency component responsible for HRV), TP (total power; the spectral power of all the cyclical components responsible for HRV). In addition, we also included LFnu and HFnu, which are LF and HF expressed in normalized units (nu).[1] In terms of interpretation, RMSSD and HF are both measures of short-term HRV that reflect vagal tone, the vagus nerve being the main contributor to parasympathetic activity (Laborde, Mosley, & Thayer, 2017). LF, on the contrary, is not easily interpretable, as it is the result of the interplay between sympathetic, parasympathetic, and baroreflex activity (Heathers, 2014). As to TP, it is a measure of overall HRV and expresses how much the ANS responds. Lastly, LFnu and HFnu can be understood as the relative value of LF and HF in proportion to TP, since VLF becomes negligible after detrending the data.

Data analysis procedures

As we saw, IIMT involves the alternation between musical and verbal moments during sessions. These two modes of communication are arguably very different in terms of their aesthetic, cognitive, emotional, physiological, cultural, and social dimensions. Therefore, we decided to distinguish between music improvisation and verbal exchange when conducting the analysis. The first 10 minutes of each session were analyzed separately as well, since the preparatory interventions constituted a distinct additional activity that was neither music-making nor talking.

With the help of the video recordings, we first identified the moments of preparatory intervention, music-making, and talking, and then calculated three separate session averages for all the HRV metrics described above. The music moments included in the analysis were only the malletKAT improvisations because this instrument was used in every session (bar one), whereas the djembe was only used intermittently. This had the added benefit of making the improvisations more comparable within and across clients, since they all involved one and the same instrument.

Heart rate data were analyzed through visual analysis, which remains the most common method used in single-case experimental designs (Smith, 2012). When performing a visual analysis, the data points of each variable are first plotted and then inspected for changes in level, trend (i.e., slope), and variability (Byiers et al., 2012). Since our study design involved the systematic alternation of two experimental conditions, we were on the lookout for clear and pronounced zigzag patterns. If present, such patterns would point towards the existence of an association between RFB and the measured HRV indices. One exception were the HRV indices of the preparatory interventions, for which we performed a statistical analysis of the means

[1] LFnu = LF/(TP − VLF) and HFnu = HF/(TP − VLF), with VLF (very low frequency) corresponding to all the cyclical components below LF.

obtained in each condition. Indeed, we knew RFB would have a strong, immediate, and systematic effect on HRV compared to the control interventions because the latter were not designed to maximize HRV. Thus, instead of plotting each HRV index separately and performing a visual analysis, we compared the effects of the preparatory interventions using *t*-tests and presented the results in a single table.

Results

As expected, overall HRV was substantially higher during RFB for all three clients, and these gains were mainly driven by strong increases in low frequency (LF). Indeed, compared to the control interventions, the difference in HRV levels was statistically significant for total power (TP), LF, and low frequency in normalized units (LFnu) for all three clients (see Table 1). The systematic decrease in high frequency (HF) during RFB is due to the fact that RFB concentrates most of the spectral power around the breathing frequency, which is located in the LF band (0.04 – 0.15 Hz) when breathing at around six breaths/min (6 cycles per min = 0.1 Hz). Consequently, when performing RFB the spectral power that would normally be located in HF temporarily moves into LF.

Table 1. t-test results for HRV measures during the preparatory intervention

	RFB			Control			95% CI for Mean				
	M	*SD*	*n*	*M*	*SD*	*n*	Difference	*t*	*df*	*p*	*d*[c]
Client 1											
TP	9.22	0.39	5	8.32	0.39	5	.33, 1.46	3.65**	8	.006	2.58
LF	9.07	0.37	5	7.39	0.58	5	.97, 2.38	5.49**	8	.001	3.88
HF	6.92	0.66	5	7.35	0.48	5	-1.27, .42	-1.16	8	.278	
LFnu[b]	87.82	4.93	5	52.00	18.91	5	12.66, 58.99	4.10*	4.54	.011	3.85
Client 2											
TP	8.00	0.45	9	6.07	0.55	9	1.43, 2.43	8.20**	16	<.001	4.10
LF	7.94	0.44	9	5.23	0.49	9	2.23, 3.17	12.25**	16	<.001	6.12
HF	4.72	0.67	9	5.27	0.63	9	-1.19, .10	-1.78	16	.094	
LFnu[b]	95.80	1.11	9	49.08	6.51	9	41.69, 51.75	21.21**	8.46	<.001	14.58
Client 3											
TP	8.63	0.24	6	6.44	0.20	6	1.90, 2.47	17.16**	10	<.001	10.85
LF	8.58	0.23	6	5.18	0.34	6	3.02, 3.77	20.18**	10	<.001	12.76
HF	5.43	0.44	6	6.01	0.16	6	-1.00, -.15	-3.01*	10	.013	1.91
LFnu	95.70	0.85	6	31.28	4.52	6	59.68, 69.15	34.28**	5.35	<.001	29.63

[b] Equal variances not assumed (Levene's test was significant with $p < .05$).

[c] Formula used to calculate the effect size (Cohen's *d*): $2|t| / \sqrt{df}$

*$p < .05$, **$p < .01$

When looking at the 45 minutes of music therapy following the preparatory intervention, HFnu during music-making was the only HRV index that displayed uninterrupted sequences of systematic ups and downs corresponding to the alternation of the two conditions. As shown in Figure 2, HFnu during malletKAT improvisations was systematically associated with the practice of RFB, either throughout the entire therapy process (Study 1) or during a significant part of it (Study 2 and 3). Interestingly enough, no systematic pattern across studies was found for HRV levels during verbal exchange. Such an association was only visible in Study 1, where HFnu during talking displayed a similar sequence to HFnu during improvisations (see Brabant, Solati, et al., 2017).

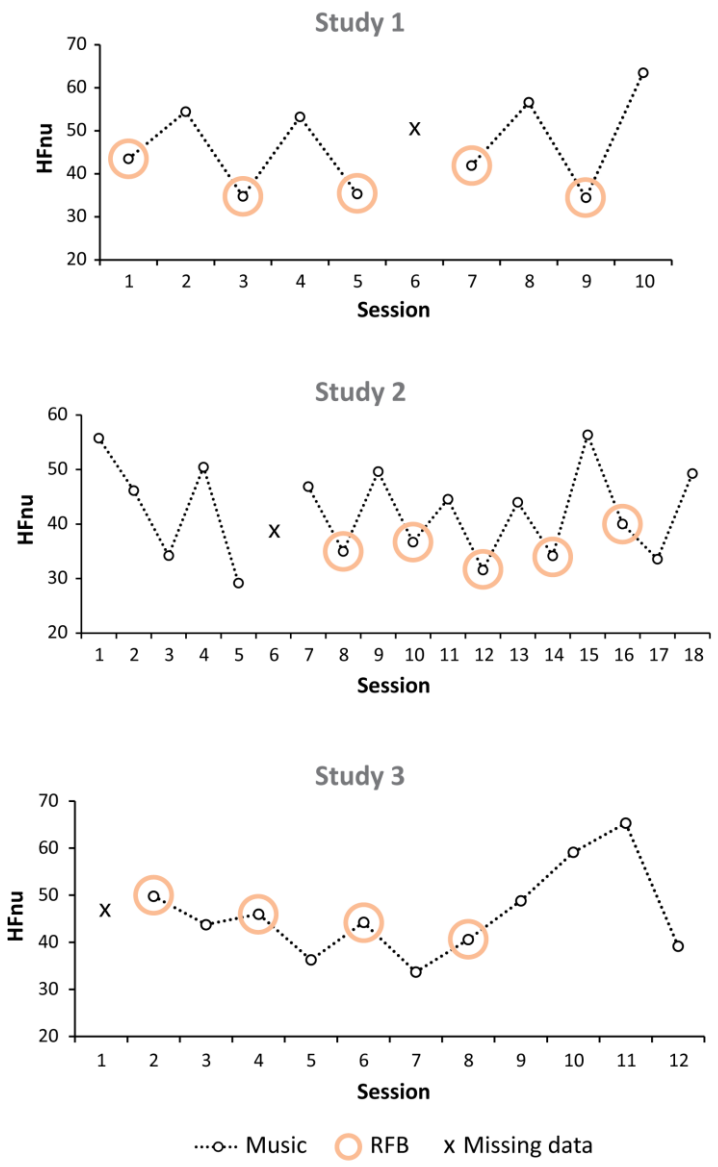

Figure 2. HFnu during music improvisations.

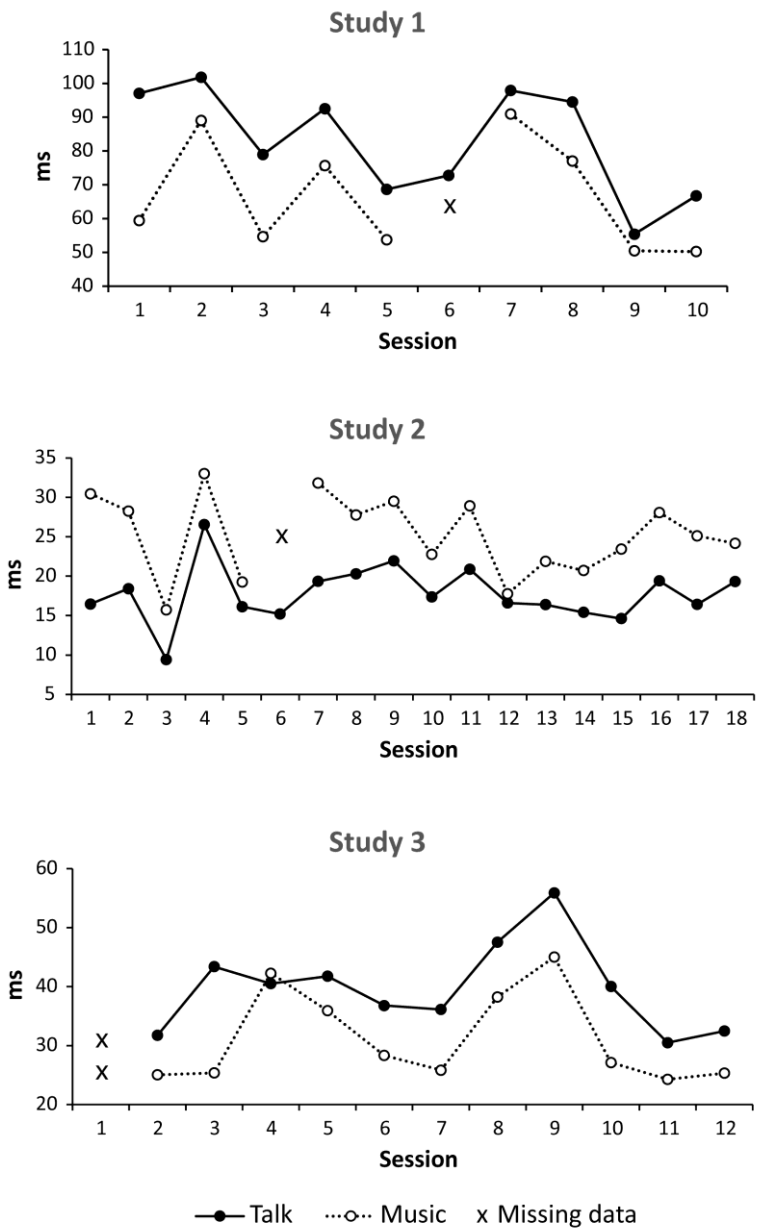

Figure 3. HRV levels (RMSSD) during talking and music-making.

An additional finding was that the direction of the change in HFnu differed depending on the client. With the two healthy clients (Study 1 and 2), HFnu was lower in sessions starting with RFB, which indicated that the clients were most likely experiencing higher levels of negative arousal during the music improvisations that followed RFB. On the contrary, for the client diagnosed with anxiety disorder (Study 3), HFnu was higher after RFB, but only during the first half of the therapy process. This phase also happened to be identified as the more difficult phase of the therapy (Brabant, van de Ree, & Erkkilä, 2017). Therefore, it would appear that as

emotional processes were more difficult, the improvisations played after RFB were nonetheless comparatively easier than the other improvisations played in that same phase. In the second half of the therapy process, no association was found between RFB and HFnu during improvisations (see Figure 2).

The HRV analysis of the moments of verbal exchange and music improvisation revealed that these two activities had distinct HRV signatures, with one being systematically more stressful than the other. Interestingly, the clients differed in terms of which activity they found more stressful. As can be seen in Figure 3, RMSSD during improvisations was systematically lower than during verbal exchange for Client 1 and 3, which means that music-making was perceived by them as more stressful than talking. The opposite was true for Client 2, for whom music-making was *less* stressful than talking. It is worth emphasizing that for all three clients, these differences remained consistent throughout the entire therapy process independently of its length or the preparatory intervention being used.

Obviously, this last finding is not directly related to the use of any preparatory intervention, since the observed differences in RMSSD remained unaffected by the alternation in the experimental conditions. Nonetheless, we deemed it worth mentioning, as it represents not only important information about the role played by music in improvisational music therapy, but also about the intrinsic differences between music-making and verbal expression.

Discussion

The main findings derived from the three studies were as follows. First, it appeared that RFB had a presumptive effect on autonomic arousal during malletKAT improvisations, as evidenced by the systematic changes in the relative power distribution between LF and HF (i.e., HFnu). Second, this effect was visible in an unbroken series of sessions that encompassed either the entire therapy process (Study 1) or a substantial part of it (Study 2 and 3). Lastly, RFB was followed either by decreased levels of HFnu (Study 1 and 2) or increased levels of HFnu (Study 3).

In reflecting upon these findings, one might wonder why during IIMT, HFnu was the only HRV metric associated with the presence or absence of RFB. We attributed this to the fact that HFnu is a relative index, whereas all the other indices are raw, absolute values. Absolute HRV indices tend to display strong natural variations from one measurement to the next (Pinna, 2007), both between people (inter-individual variability) and within the same person (intra-individual variability). This means that if a presumed intervention effect is smaller than these naturally occurring variations, it might be masked by them and become undetectable through visual inspection and statistical analysis.

Relative indices, on the other hand, are much less sensitive to random variations in overall

HRV because they are expressed as proportions of overall HRV. Consequently, they tend to have lower coefficients of variation compared to absolute indices (Burr, 2007). However, their downside is the ambiguity and uncertainty surrounding their interpretation. Indeed, among the HRV indices chosen for the analysis, only RMSSD and HF have a clearly defined and non-controversial physiological origin (Laborde et al., 2017). As we saw above, both are an expression of parasympathetic activity and vagal tone, with higher levels of RMSSD and HF corresponding to more parasympathetic activity (i.e., lower stress levels).

Given the ambiguity surrounding HFnu, the safest way to proceed would be to interpret this metric within the context of data triangulation, where it can be compared to other physiological, psychological, or behavioral measures. For instance, in Study 1, we found that lower HFnu was related to the presence of more negative emotions during talking and more negative facial expression (Brabant, Solati, et al., 2017). A similar association was found in Study 3, where HFnu and session smoothness were following the same high-low-high curvilinear trend (Brabant, van de Ree, & Erkkilä, 2017). For the purpose of this discussion, we will therefore assume that HFnu can be interpreted in the same way as HF, with lower HFnu indicating higher stress levels and emotional difficulty, and vice versa.

Although it is of course too early to make any strong claims regarding the existence of systematic and generalizable effects of RFB on emotional processes during music therapy, we nonetheless would like to propose a tentative model to explain the results obtained so far. This model is based on the assumption that HFnu can serve as a reliable indicator of stress levels and emotional difficulty.

We propose that RFB has two main effects when used within music therapy (and possibly creative arts therapies in general). First, it opens clients up, allowing them to better access and express emotions that usually remain unexpressed. Second, it helps clients manage difficult emotions by reducing stress levels in case of excessive arousal. In other words, we believe RFB functions both as a catalyst and a regulator, deepening and supporting the emotional processes already occurring during music therapy. Assuming that these two effects are always simultaneously at work, their joint result will differ depending on the client and the emotional issues currently at hand. For example, someone whose stress level is already excessively elevated because of a pre-existing emotional disorder may benefit from stress reduction (cf., Study 3), whereas clients with a lower arousal baseline (cf., Study 1 and 2) will experience temporary stress increases because of the normally unexpressed emotions evoked through the process. Although the resulting HRV changes proceed in opposite directions, in both cases they are actually beneficial to the therapy process because the changes correspond to what the clients are able to manage. We thus see RFB as an adaptive intervention whose outcome is always an expression of the clients' current emotional needs.

To better understand this last point, it may be useful to apply the concept of "window of tolerance" (Ogden & Minton, 2000; Siegel, 1999). Originally developed within the context of trauma therapy, a window of tolerance refers to the zone of optimal arousal where emotions can be tolerated and information integrated. If arousal levels become too high, clients enter a state of hyper-arousal, characterized by panic, fight-or-flight reactions, hyper-vigilance, and disorganized cognitive processing. Conversely, at the other end of the spectrum, clients might enter a state of hypo-arousal, whose typical manifestations are numbness, passivity, and disabled cognitive processing (see Figure 4). In both cases, therapeutic work is not possible. Thus, for therapy to proceed optimally and be successful, the therapist must ensure that the client remains or returns inside the window of tolerance.

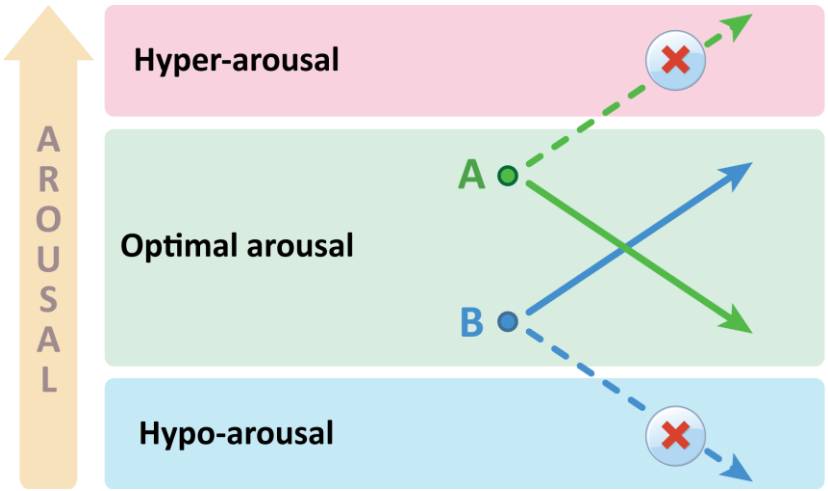

Figure 4. Window of tolerance model applied to RFB.

Applying these ideas to our results, it comes as no surprise that Client 1 and 2 would experience decreases in HFnu (i.e., increased arousal), whereas Client 3 would display HFnu increases (i.e., decreased arousal). As illustrated in Figure 4, it would be counter-productive for Client A to become even more stressed through RFB, because he or she would be entering the hyper-arousal zone. Instead, what such a client needs is a reduction in stress levels (downward arrow). The opposite is true for Client B, whose default arousal level is lower than in Client A. Such a level would be typical for healthy individuals presenting low amounts of fear and anxiety. For such clients, further reducing arousal levels would be unhelpful, as it would lead them into the hypo-arousal zone. However, punctual increases in arousal (e.g., because of the processing of negative emotions) is unproblematic, since Client B will still remain inside his/her regulatory boundaries.

While we are not aware of any research specifically addressing the impact of RFB on emotional processes during therapy, we found corroborating evidence to support our model in a study on emotional regulation during social interaction (Butler, Wilhelm, & Gross, 2006). In that

study, healthy women first underwent temporary parasympathetic activation through a slow-breathing exercise, then negative emotions were induced with an upsetting film, and finally the women were asked to talk in pairs about their emotional experience. The authors found that the participants with higher HRV levels during the breathing task also experienced and expressed more negative emotions during the conversations. This is very much the same pattern as the one we found for our healthy clients in Study 1 and 2, with HRV data showing that music-making was emotionally more difficult (lower HFnu) in sessions starting with the breathing intervention (higher HRV). Butler et al. (2006) further support our hypothesis by speculating that their results would probably have shown the opposite relationship if their participants had presented emotional disorders or pathologically high levels of stress. In such a scenario, the authors would have expected a decrease in negative emotional reaction instead of an increase (similarly to the first therapy phase in Study 3).

The last finding we need to discuss is the systematic HRV difference between talking and music-making that was found in all three clients. The inter-individual differences regarding which activity was perceived as more stressful could not be attributed to the clients' clinical status, as Client 1 (generally healthy) and Client 3 (diagnosed) presented the same HRV pattern, with music-making systematically more stressful than talking. However, we believe that one possible explanation might be found in the clients' cultural background. Indeed, the only client for whom talking was more stressful than improvising was Client 2, who was also the only client with a Chinese background.

Chinese culture tends to distinguish itself from European culture in terms of verbal communication. For example, addressing issues in a direct and straightforward manner is considered impolite in China (Scarborough, 1998). When it comes to personal problems and emotional issues, they are usually not discussed openly, as this might be interpreted as a sign of weakness and lead to loss of face (Myler & Tong, 2008). Another important cultural feature is the idea that the interests of others come before one's own interests. Consequently, there is a strong focus on affective self-control and the displaying of what Zhong (2011) calls "surface harmony". In this context, it is not surprising that music, with its symbolic and non-verbal qualities, would offer the client more expressive freedom and be experienced as less stressful than talking.

Assuming that our two European clients were representative examples of how Western clients would typically react to music therapy, the findings presented here can be interpreted in two different ways. The observed increase in stress levels during music-making could simply be due to the fact that the activity is unusual compared to talking, especially for clients with little or no musical training. However, if this were indeed the case, we would expect the difference between talking and improvising to diminish with time, under the influence of a learning or habituation effect. As can be seen in Figure 3, this was not the case in our studies.

A second explanation is that the difference in stress levels are due to the intrinsic qualities of music as an expressive medium. This explanation is more compatible with the observed stability in the HRV differences, since intrinsic qualities would, by definition, remain unchanged. The higher stress levels during music-making compared to talking support the idea that music provides clients with better access to clinically-relevant emotions. Assuming that these emotions were predominantly difficult and negative, this might explain the lower RMSSD levels observed during music improvisations.

On a more general level, these findings lend support to something that music therapists have implicitly known for a long time—that music-making has specific qualities that clearly distinguish it from verbal interaction. Better understanding these qualities is fundamental for raising the profile of music therapy and highlighting its uniqueness in relation to purely verbal forms of psychotherapy.

Summary

The common findings of our three exploratory studies provide preliminary empirical support for the beneficial influence of RFB on emotional processes during therapy. Furthermore, they offer music therapists new and valuable information about the differences between verbal and musical expression. With regard to our research questions, we did find a link between RFB and a specific HRV parameter during music improvisations (RQ1). This link pointed towards either increased or decreased emotional difficulties depending on the type of client and the therapy phase. Thus, RFB appeared to function as an individualized and adaptive intervention (RQ2). Our proposed model based on the notion of window of tolerance explains why different clients would respond differently to a relaxation-inducing intervention such as RFB.

Limitations and future research

Although single-subject experimental designs are very useful for examining new treatment approaches prior to engaging in larger between-group studies (Borckardt et al., 2008; Byiers et al., 2012), they do not allow the drawing of conclusions beyond the individuals being studied. In other words, it is not possible at this point to know whether the findings from our three participants can be generalized. This is especially true in the case of RFB, whose effects appear to depend on the type of client and their current needs. Therefore, in order to better understand and anticipate the type of effects that can be expected from RFB, further research involving different client populations would be required.

Because the three cases presented here were focused only on therapy processes, another question that remains open is the actual improvement that RFB can provide in terms of therapy outcome. It is reasonable to assume that RFB should have a positive impact on outcome

measures, but this does not necessarily mean the effect is clinically significant. To answer this question, outcome-oriented trials using a parallel group design would need to be conducted. Trials of this kind already exist in the literature (see, e.g., Goessl et al., 2017), but they usually involve RFB used as a stand-alone intervention in addition to standard care and not RFB conceived as an integral part of a specific psychotherapy method.

Implications and practical recommendations

RFB appears to be a promising addition to music therapy, with the apparent ability to prepare clients for deeper therapeutic work. In the light of the existing evidence, we encourage clinicians to start integrating RFB into their practice of music therapy. Together with the additional knowledge derived from large randomized controlled trials, this might eventually lead to the establishment of a valid and innovative therapy model characterized by better outcomes as well as shorter therapy durations.

For music therapists who would like to start implementing RFB, the main hurdle is the technical equipment and know-how required to perform the initial breathing assessment. Fortunately, it is nowadays no longer necessary to invest in heart rate monitors or electrocardiogram systems, as heart rate can be measured reasonably accurately through smartphone sensors and cameras, in combination with dedicated apps. Some of these apps are also able to analyze HRV, making it theoretically possible to perform the entire breathing assessment using only smartphone technology.

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