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„Therapeutic interaction as predictor of change for mental health outcomes in improvisational music therapy (IMT) for children with autism spectrum disorder (ASD)"

verfasst von / submitted by

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Abstract (English)

Autism spectrum disorder (ASD) is a heterogeneous neurodevelopmental disorder characterized by social interaction and communication impairments. Music therapy (MT), using mainly nonverbal musical interaction, is considered potentially effective in promoting social reciprocity and therefore in addressing developmental shortcomings in ASD. Based on previous research establishing a strong positive relationship between social interaction and communication, increases in the former were believed to predict increases in the latter. 47 children, ages 6 to 12, diagnosed with ASD, were randomly allocated to and participated in either 12 sessions improvisational MT or play therapy (PT), a washout period for three months and the administration of the opposite intervention. All participants were assessed for levels of interaction and communication before and after each intervention. A multiple regression analysis (n = 24) showed that changes in interaction and gender explained a significant proportion of the variance in changes in communication in autistic children who underwent MT, *adjusted* R^2 = .26, F (3,06), p = .04. The found negative relationships indicate that improvements in social interaction are associated with deteriorations in social communication skills, b = -7,92 and p = ,02, and that males showed less improvements in social communication than females, b = -10,29 and p = ,03. No significant relationships were found in the control PT intervention, n = 23. These limited findings challenge the hypothesized relationship between social interaction and communication, but nevertheless suggest that social interaction is an important factor that should be targeted in MT.

Keywords: autism spectrum disorder, social interaction skills, music therapy, randomized controlled trial

Abstract (German)

Autismus-Spektrum-Störung (ASS) ist eine komplexe neurologische Entwicklungsstörung, die mit Beeinträchtigungen der sozialen Interaktion und Kommunikation einhergeht. Musiktherapie (MT), welche hauptsächlich mit nonverbaler musikalischer Interaktion arbeitet, gilt als potenziell wirksam in der Förderung sozialer Gegenseitigkeit und dadurch in der Behandlung von Entwicklungsdefiziten bei ASS. Basierend auf früheren Untersuchungen, die einen engen positiven Zusammenhang zwischen sozialer Interaktion und Kommunikation feststellten, wurde angenommen, dass Verbesserungen der sozialen Interaktion Verbesserungen der Kommunikation vorhersagen. 47 Kinder zwischen 6 - 12 Jahren, mit einer ASS-Diagnose, wurden zufällig entweder 12 Sitzungen Improvisations-MT oder Spieltherapie (ST) zugeteilt und nahmen daran teil, danach folgte eine dreimonatige Pause und die Verabreichung der jeweils anderen Intervention. Alle Teilnehmer*innen wurden vor und nach jeder Intervention auf ihre Interaktions- und Kommunikationsfähigkeit hin untersucht. Eine multiple Regressionsanalyse (n = 24) zeigte, dass Veränderungen in der Interaktion und das Geschlecht einen signifikanten Anteil der Varianz in Veränderungen in der Kommunikation bei autistischen Kindern erklärten, die sich einer MT unterzogen, *bereinigtes* R^2 = .26, F (3,06), p = .04. Die gefundenen negativen Beziehungen deuten darauf hin, dass Verbesserungen der sozialen Interaktion mit Verschlechterungen der sozialen Kommunikationsfähigkeit einhergehen, b = -7,92 und p = ,02, und dass Jungen weniger Verbesserungen in der sozialen Kommunikation zeigten als Mädchen, b = -10,29 und p = ,03. In der Kontroll-ST-Intervention (n = 23) konnten keine signifikanten Beziehungen festgestellt werden. Diese begrenzten Ergebnisse stellen die bisher angenommene Beziehung zwischen sozialer Interaktion und Kommunikation in Frage, deuten aber dennoch darauf hin, dass soziale Interaktion ein wichtiger Faktor ist, der in MT gezielt gefördert werden sollte.

Schlüsselbegriffe: Autismus Spektrum Störung, Soziale Interaktionsfähigkeiten, Musiktherapie, randomisierte kontrollierte Studie

I Theoretical background

1.1. Autism spectrum disorder

Autism spectrum disorder (ASD) is a complex neurodevelopmental disorder characterized among others by core difficulties in social interaction and communication, restrictive and repetitive behaviours as well as in some cases strengths in varied domains (American Psychiatric Association, 2013). Observations presenting lived experiences with ASD depict difficulties especially in perceiving, sensing, moving, and emoting all of which form the base to interact, relate, and communicate in life (Robledo et al., 2012). Nevertheless, since the first description of ASD reports of intact musical skills have been noted, as well as enhanced interest and ability for music compared to neurotypicals (Quintin, 2019). Approximately 2 % of children are believed to be affected by ASD, which usually manifests in early childhood and persists throughout life (Bitsko et al., 2022; Maenner et al., 2020). Furthermore, the condition is believed to be approximately 4 times more common in males compared to females (Maenner et al., 2020; Volkmar et al., 2014). Due to ASD's great heterogeneity in its aetiology, there is little consensus on which treatments are most promising with numerous approaches putting emphasis on different aspects of its clinical picture such as e. g. social, cognitive, and perceptual (Haker et al., 2016; Happé & Fletcher-Watson, 2019).

1.2. Social interaction

The nature of interaction between a child and an adult combined with the social environment plays a central role in the child's early development: in fact, it is an interaction's quality with a primary caregiver that is critical for the child's social (Black & Logan, 1995; Cole et al., 2009), emotional as well as cognitive growth (Bornstein & Lamb, 2015; Harrist & Waugh, 2002; Leclère et al., 2014). If we investigate social interaction as a process involving at least two people – in our case the patient and the therapist - we need to put an emphasis on interactive factors influencing how autistic children interact or fail to interact socially. However, conceptualizations of social interaction are not uniform. Defined by the American Psychiatric Association (2013) social interaction can be divided into three subdomains: (a) deficits in social-emotional reciprocity, (b) deficits in nonverbal communicative behaviour used for social interaction and (c) deficits in developing, maintaining, and understanding relationships. Furthermore, the level of social interaction can be measured on a broad (e.g. Diagnostic and Statistical Manual of Mental Disorders 5 (DSM 5) criteria) or on a more narrow

level (Lai et al., 2015), with narrow constructs representing more precise subdomains of broader constructs, that additionally include associated psychological constructs as e.g. social engagement and joint attention. Those narrow constructs furthermore work with a range of associated behavioural examples, such as e. g. difficulties in turn-taking in conversations, initiation of interaction and atypical eye gaze patterns (Kim et al., 2008; Wood-Downie et al., 2021). It is not surprising that in a therapeutical context the interplay between a patient and his/ her therapist, the level of their interaction, is thought to have a significant impact on the efficacy of interventions (Bertamini et al., 2021). Overall, social interaction refers to the ways in which humans engage with each other in social situations, including verbal as well as non-verbal behaviours as observed e.g., through eye contact, facial expressions, and body language.

1.3. Music therapy

As music is regarded as a "social art" and many deficits in ASD are found in the social domain, it comes as no surprise that researchers aim to identify music's potential in treating the aforementioned developmental shortcomings. As defined by Bruscia (1998, p.20), music therapy (MT) is "a systematic process of intervention wherein the therapist helps the client to promote health, using musical experiences and the relationships that develop through them as dynamic forces of change". More specifically, MT is described as a child-centred approach that uses mainly non-verbal musical interaction and therefore is similar to early reciprocal interactions between primary caregivers and infants (Holck, 2004a, 2004b; Hughes, 1995; Pavlicevic, 1997; Robarts, 1996; Trolldalen, 2005). Additionally, MT can employ improvisation as a primary therapeutic tool, observed through the flexible, spontaneous, and creative use of musical elements. For example, when working with children who may have different needs and abilities from session to session, improvisation allows the therapist to not only flexibly adapt musical activities to meet the child’s current needs, but also to provide children with a safe space to experiment, which can be fun and engaging at the same time (Nordoff et al., 2007).

1.4. Autism spectrum disorder, social interaction & music therapy

Observations from patients affected by ASD depict great variation in impairments and associated behaviour representations with difficulties being particularly pronounced in interacting, relating, and communicating in life (Robledo et al., 2012). The main thought is that musical activities, as alternative and creative means of expression, support those exact key elements of social abilities (Lense & Camarata, 2020). In a therapeutical context, musical activities are shared between a patient and his/ her therapist, who as stated by Holck (2002) use 'response evoking techniques' that involve creating reciprocally meaningful and enjoyable musical interaction themes in accordance with the child's expression and focus of attention. Neuroscience and psychological research have noted MT's efficacy in affecting social abilities, enabling the autistic child to perceive that the therapist's music has something to do with him/ her (Kim et al., 2008) and enabling the child to engage at his/ her level and interest. It was further suggested that MT offers the autistic child a mean of self-expression, emotional communication and social interaction, that can be more easily accessed by the child than other mediums of treatment (Alvin, 1978; Caria et al., 2011; Carpente, 2017; Edgerton, 1994; Gold et al., 2006; Mössler et al., 2013; Quintin et al., 2011; Robarts, 1996; Simpson & Keen, 2011; Trevarthen, 2002; Wheeler et al., 2008; Wigram & Gold, 2006). This process of mutually processing one's own and other's actions, as stated by Mundy, Sullivan, and Mastergeorge (2009), enables an automaticity that is fundamental to social learning (Landa et al., 2011). Thus, early musical interventions that enable the acquisition of social interaction skills are shown to have potent effects on later language, play, and social outcomes (Bono et al., 2004; Sigman & Ruskin, 1999; Toth et al., 2006). Overall, the acquisition of social interaction in MT, observed through e. g. engaging in musical activities with the therapist, taking turns playing instruments and responding to musical cues from the therapist, is aimed at enabling affected patients to transfer music-related gains into the child's and caregivers' everyday life.

1.5. State of the art research findings

For example, on a narrower level it was found that MT was able to increase different markers of social interaction, such as e.g. joint attention ability (De Falco & Venuti, 2006; Kim et al., 2008), reciprocity level (Geretsegger et al., 2014; Landa, 2007), imitation ability (Landa, 2007), affective sharing (Kim et al., 2009; Wetherby et al., 2004), and child initiation of interaction (Geretsegger et al., 2014; Landa et al., 2007). In another study conducted by Kim et

al. (2008) MT generated lengthier events of eye contact and similar to the former findings encouraged young children with ASD to join in with and initiate interaction with the therapist. In line with this, Sharda et al. (2018) also found music-based interventions to result in higher post-intervention communication scores compared to a control condition. A research group around Mössler et al. (2019) emphasized the importance of the therapeutic relationship in predicting social communication skills in children with ASD undergoing MT. In this study, the therapeutic relationship between therapist and child, constituted one element of the overall concept of social interaction and was effective in predicting changes in symptom severity.

Nevertheless, one high-quality randomized clinical trial with a large sample (n = 364), also emphasising the importance of the therapeutic interaction, resulted in less promising effects. The study's findings suggest that even though MT had shown promising effects for children's relationship with their caretakers, quality of life and participation in family life, at the end of the treatment musical interventions did not seem to improve social skills in ASD (Bieleninik et al., 2017). Similarly, a study conducted by Mössler et al., (2020) investigating the effects of relational factors, namely attunement between child and therapist, on changes in post-hoc mental health outcomes, was not able to obtain significant effects of this relationship. These negative findings are supported by a recent systematic review by Geretsegger et al., (2022) concluding that a (very) low certainty of evidence left no clear basis on whether MT is having any effects on social interaction, and verbal/ non-verbal communication at the end of intervention. This (very) low certainty of evidence was explained by insufficient blinding and issues with the study design, which are common limitations in studies conducted in this area.

In conclusion, conflicting research results create confusion and show that there is still little evidence on how exactly MT, oriented at improving social interaction, can reduce the atypical development in ASD (Baker et al., 2015), and how those relational factors might contribute to generalized changes in autistic traits (Lerner et al., 2012). Even though social interaction deficits are acknowledged as one of the core impairments in autism (American Psychological Association, 2013), they are only examined as outcome variables (Volkmar & Reichow, 2010) rather than potential outcome predictors of the effect of MT on social skills (Mössler et al., 2019). We conclude that the mixed and rare evidence for social improvements in children with ASD highlights a research gap in regards of social interaction acting as a potentially important outcome predictor in the development of autistic symptoms following MT.

1.6. Research question & hypothesis

While social interaction and social communication are closely related constructs, they can be separated based on their specific focus and function. Social interaction focuses on the ways in which individuals engage with others in social situations, whereas social communication focuses on the exchange of information and ideas between individuals. Both being closely related and important aspects of the therapeutic process, further research is needed to better understand the nature of this relationship and the factors that may influence treatment outcomes. Based on a study by Mössler et al. (2019), finding the therapeutical relationship to be an important predictor of changes in symptom severity in children with ASD, it was deduced that the more comprehensive concept of social interaction should also be able to act as a valid predictor of changes in mental health outcomes.

More precisely, we expected that there will be a positive relationship between changes in level of interaction and changes in level of communication in autistic children undergoing improvisational MT. The proposed thesis therefore intends to investigate whether "change in the perceived child - therapist level of interaction, seen as a crucial relational factor in MT with autistic children, is an important predictor of change in the development of core autistic symptoms, namely changes in a child's level of social communication." The research question and hypothesis read:

Research question: "Do changes in a child's level of interaction (rated by the therapist after the first and after the last session of therapy) predict changes in the child's level of social communication (rated by the educator/ teacher before and after each intervention type)?"

Research hypothesis: "Increases in therapist's subjective reports of a child's level of interaction are able to predict increases in the child's level of social communication rated by educators/ teachers."

II Empirical Part

2.1. Methods

2.1.1. Research objectives

This work is part of the bigger binational study Music4Autism (M4A), which investigates mental health responses to a 3-months music-based- intervention compared to a matched play-based intervention that served as an active control condition. The focus of this thesis is on MT only. The M4A project aimed at replicating and expanding findings by Sharda et al., (2018), who found MT to improve social communication skills in autistic children following improvisational MT.

2.1.2. Research design

The M4A project, in a European context with an increased sample size, took place in outpatient units in Austria (Vienna) and Norway (Bergen) and was designed as an assessor-blinded crossover randomized controlled trial. Regarding the recruitment, the Faculties of Psychology could draw on a network of healthcare professionals and collaborators of the Department of Child and Adolescent Psychiatry of the Medical University of Vienna and various ASD advocacy groups (e.g., Österreichische Autistenhilfe) in Vienna, but also neighbouring cities such as St. Pölten and Linz were included. Parents of the participants had to give a written informed consent. Ethical approval was obtained by the Ethics Committee of the University of Vienna and the Regional Committee for Medical and Health Research Ethics (REK) of West Norway.

2.1.3. Participants

Children between the ages of 6 - 12, who had an official diagnosis of ASD, diagnosed with the Autism Diagnostic Observation Schedule (ADOS) or with the Diagnostic Interview for Autism – revised (ADI-R), who were not receiving MT at the moment of conductance or had received it recently, nor had any medical or fMRI contraindications, were eligible to take part in the study.

The final sample from the music-based intervention consisted of $n = 24$ participants, of whom 5 were female (20,8 %) and 19 (79,2 %) were male with an average age of $M = 8{,}54$ ($SD = 1{,}97$) ranging from 6 to 12 years. Participants showed SRS total T-scores, representing the

level of autistic traits, ranging from a minimum of *T* = 57 to a maximum of *T* = 127 with an average T-score of *M* = 91,12 (*SD* = 18,99), reflecting overall severe deficits in reciprocal social behaviour.

In the analysis of the play-based intervention, a total sample of *n* = 23 participants was achieved, of whom 3 were female (13 %) and 20 (87 %) were male with an average age of *M* = 8,87 (*SD* = 1,96) ranging from 6 to 12 years. Participants showed SRS total T-scores, ranging from a minimum of *T* = 57 to a maximum of *T* = 131 with an average T-score of *M* = 95,17 (*SD* = 20,45), reflecting overall severe deficits in reciprocal social behaviour.

Based on previous power analysis using G*Power (Faul et al., 2009), this study aimed to recruit at least 85 children, to obtain .80 power at the standard .05 alpha error probability for an effect size of *d* = 0.15. This work is based on trials conducted between the period of September 2021 and May 2023 and on a smaller subsample (*n* = 47) of the ongoing larger study.

2.1.4. Measurements

The level of autistic traits was measured using the Social Responsiveness Scale 2. Edition (SRS-2; Constantino & Gruber, 2012). The DSM-5 based inventory, with its 65 items, is filled out by parents, evaluating ASD-related symptomatology. The ratings target a child's social, as well as communicative and stereotyped behaviour over the past 6 months, such as e. g. the ability to recognize social cues of others, the ability to interpret social behaviours, the ability to reciprocally communicate in social situations, the degree of motivation to participate in social interactions with others and stereotyped interests. Items are rated on a 4-point Likert scale ranging from 1 (not true) – 2 (sometimes true) – 3 (often true) to 4 (almost always true). The total raw score is scaled in relation to age and transformed into T-scores (*M* = 50, *SD* = 10), with higher scores indicating greater severity in ASD symptoms (T-scores of 59 or lower = no indication of ASD; T-scores of 60 – 65 = mild to moderate impairments that are still clinically relevant; T-scores of 66 – 75 = impairments of clinical importance typically found in children with moderate ASD symptomatology; T-scores of 76 and higher = severe deficits in social behaviour that impact every day's life).

The study of the child-related predictor, namely social interaction was rated by therapists using a self-constructed "Monitoring Scale", an observational coding system to extract behavioral exemplars of different child variables in the therapeutical process. The scale consisted of 14 items, which were rated by therapists at two different timepoints, right after the

1st and right after the last session (usually the 12th session) of each intervention type. It used a 5-point Likert scale ranging from never – rarely – sometimes - usually – always to no answer.

Based on the aforementioned definition of social interaction used by Lai et al., (2015), who state that social interaction is best measured with associated psychological constructs as e. g. social engagement, joint attention and imitation, which furthermore work with a range of associated behaviors, such as e. g. difficulties in turn-taking, initiation of interaction and atypical eye gaze patterns, we decided to use the first three items of the Monitoring scale to create an overall child's interaction score. Namely these items were: child interacts with others, child initiates interaction and child uses appropriate eye contact. For the creation of this score, raw values of the three items of the monitoring checklist were added up and an average was calculated that represented an overall child's interaction score for timepoint 1 (T1) and timepoint 2 (T2). For the creation of a general change in interaction score, the overall child's interaction value of T1 (after first session of each intervention) was subtracted from T2 (after last session of each intervention).

As one main outcome of the Music4Autism project, standardized developmental child information about level of communication was rated through the Children's Communication Checklist (CCC-2; Bishop & Cubero, 2006) filled out by educators/ teachers as a baseline measurement before the start of each intervention and after the administration of each intervention type. Since communication involves the exchange of information, ideas, and emotions between individuals, and may encompass a range of skills such as receptive and expressive language and speech production, it is aimed at measuring different aspects of pragmatic communication (e. g. speech, syntax, semantic, coherence, inappropriate initiation, stereotyped language, use of context, verbal & nonverbal communication, social relations, interests), as well as structural communication (e.g. articulation, phonology, structure, vocabulary and disclosure). The checklist consists of two main sections including 70 items in total: the first section assesses the child's communication skills in everyday situations, such as in conversation or during play, while the second section assesses the child's communication skills in more structured contexts, such as in a classroom or during speech and language therapy sessions. Specifically, the items e.g., evaluate the child's ability to follow instructions, understand jokes, initiate conversations, and use appropriate body language. Each item depicts a child's communicative behaviour, rated on a 4-point Likert scale (0 = less than once a week; 1 = at least once a week; 2 = once or twice a day; 3 = several times a day), resulting in a General Communication Composite (GCC) that is based on a specific age norm and represents a child's

overall communicative ability. The higher the GGC score, the higher a child's communicative abilities. A GCC score of 55 serves as a cut-off and represents the 10th percentile, which means that about 10 % of children of the same age scored a similar or lower score, respectively 90 % of same aged children scored higher values. Generally, a GCC score =/< 55, indicates communication impairments that should be further investigated. For the creation of a general change in communication score, the GCC value of T1 (baseline) was subtracted from T2 (post-intervention).

2.1.5. Procedure

The children eligible for the study first went through a baseline assessment, which consisted of behavioral (CCC-2) and demographical (age, gender, and level of autistic traits) measurements. Next, the children were randomly allocated to either improvisational MT or a play therapy (PT) intervention following a sequence of intervention for three months, washout period for 3 months, the opposite intervention for 3 months and follow-up measurements.

Both MT and PT consisted of 12 weekly 45-minute sessions and focused on creating a shared experience, building meaningful relationships, and strengthening self-expression. In every session, the therapist asked the child to choose four out of 12 possible musical activities/ games. Specifically, those were piano, boom whackers, djembe, xylophone, kazoo, microphone ukulele, musical-book, flute, bells, kalimba, and egg shakers for the music-based intervention. In the play-based intervention, Lego, Playdoh, beanbags, Jenga, Puzzle, Four-in-a-row, finger puppets, Halligalli, bubbles, slime, darts, and a non-musical book were used. The aims of the treatments were to foster multisensory integration, verbal and social communication, emotion regulation, turn-taking, social appropriateness, and interaction. To achieve these goals MT employed rhythmic cues, music instruments, songs, and stories accompanied by music. Whereas PT as a play-based active comparison condition used verbal interaction, toys, and the same stories without a musical component.

2.1.6. Statistical analysis

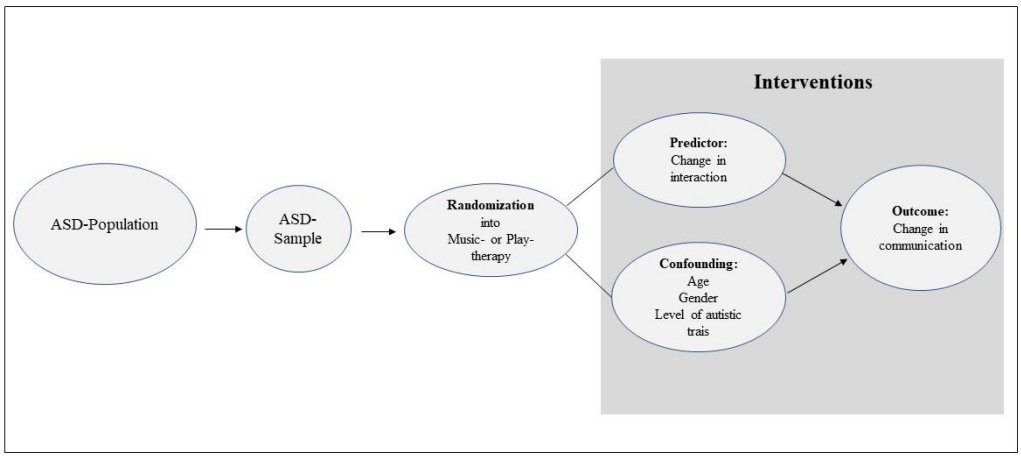
The measurements taken in this thesis, had a normal distribution, for which it was possible to use parametric statistics. Therefore, a multiple linear regression analysis was conducted for each intervention type by means of the SPSS 24 statistical software, with the significance level set at $\alpha = .05$. Based on previous research stating that in children with autism, social and communicative skills usually increase with age, and that the presence of overall

cognitive ability can predict ultimate outcomes (Volkmar et al., 2014), this multiple regression analysis controlled for potentially confounding variables, namely child's age, gender, and level of autistic traits.

In the first step, descriptive statistics for each therapeutical intervention individually and a t-test for independent samples were used to check for frequencies, means, standard deviations and possible baseline group differences. Alongside, primary correlational analyses were calculated to examine the relationship between changes in communication and various potential predictors. Moreover, assumptions were checked for conducting a multiple regression analysis.

In the second step, a multiple linear regression analysis and Cohen's effect size estimation was carried out for each intervention type separately using changes in interaction as the predictor of interest and age, gender, and level of autistic trait as control variables. Adjusted for these confounding variables, the multiple regression model gives a better estimate of the predictive power of changes in interaction on the outcome measure changes in communication. A multiple regression path model for changes in communication is presented in Figure 1.

Figure 1. Path diagram representation of the multiple regression analysis on the effect of change in interaction on change in communication.



2.2. Results

2.2.1. Descriptive baseline analysis

A t-test for independent samples was conducted, to check whether there were any group mean differences at baseline in age, gender, average level of interaction, and CCC-2 scores.

Table 1 shows that there was no homogeneity of variance in CCC-2 baseline scores between MT and PT. In other words, the variances in CCC-2 baseline scores were different for the two groups. Otherwise, there were no significant differences in mean values between the two groups.

Table 1. Levene's Test for Equality of Variances

		F	Sig.	t	df
Age	Equal variances assumed	,003	,958	-,571	45
Gender	Equal variances assumed	2,023	,162	-,699	45
Level of autistic traits	Equal variances assumed	,022	,884	-,704	45
Average Interaction after first session	Equal variances assumed	,640	,428	,296	45
CCC2Baseline	Equal variances assumed	4,777	,034*	-,087	45

*p < .05

A correlation analysis was conducted for the music-based intervention to examine the relationship between changes in communication and various potential predictors. As can be seen changes in interaction are significantly and negatively correlated r = -,40, p = 0,02 with the criterion, indicating that an increase in changes in interaction is associated with a decrease in changes in communication (see Table 2). According to Pearson, a correlation coefficient r =-,40 can be interpreted as a medium sized effect. All confounding variables, namely age, gender, and the level of autistic traits, were not significantly correlated with changes in communication. Furthermore, the results show no presence of multicollinearity, what can be seen in that there aren't any too high intercorrelations between outcome predictors (r > 0,9).

Table 2. Music therapy Correlations

		Change in Interaction over time	Change in Communication over time	Age	Gender	Level of autistic traits
Change in Interaction over time	Pearson Correlation	1				
	Sig. (1-tailed)					
	N	24				
Change in Communication over time	Pearson Correlation	-,405*	1			
	Sig. (1-tailed)	,025				
	N	24	24			
Age	Pearson Correlation	-,129	,279	1		
	Sig. (1-tailed)	,274	,093			
	N	24	24	24		
Gender	Pearson Correlation	-,391*	-,177	,144	1	
	Sig. (1-tailed)	,030	,204	,252		
	N	24	24	24	24	
Level of autistic traits	Pearson Correlation	,351*	-,207	,063	-,256	1
	Sig. (1-tailed)	,046	,166	,385	,114	
	N	24	24	24	24	24

*p < .05

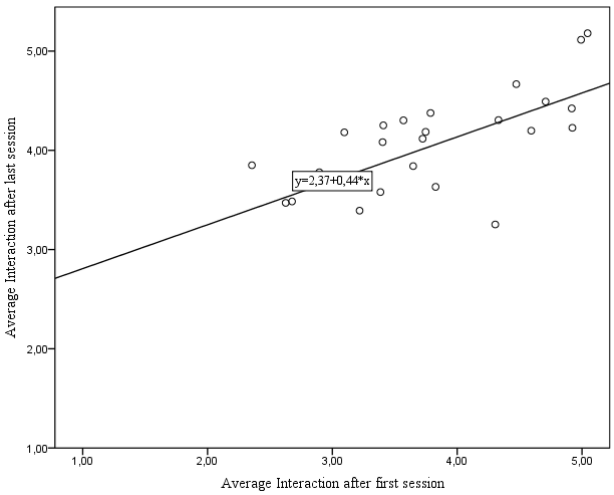
The same correlation analysis conducted for the play-based intervention, did not yield any significant correlations between the proposed predictors changes in interaction, age, gender and level of autistic traits with the outcome variable changes in communication (see Table 3). Again, the results show no presence of multicollinearity (there aren't any too high intercorrelations between outcome predictors (r > 0,9).

Table 3. Play therapy Correlations

		Change in Interaction over time	Change in Communication over time	Age	Gender	Level of autistic traits
Change in Interaction over time	Pearson Correlation	1				
	Sig. (1-tailed)					
	N	23				
Change in Communication over time	Pearson Correlation	,021	1			
	Sig. (1-tailed)	,462				
	N	23	23			
Age	Pearson Correlation	-,187	-,005	1		
	Sig. (1-tailed)	,196	,490			
	N	23	23	23		
Gender	Pearson Correlation	-,106	-,016	,108	1	
	Sig. (1-tailed)	,315	,471	,311		
	N	23	23	23	23	
Level of autistic traits	Pearson Correlation	,248	-,169	-,030	-,048	1
	Sig. (1-tailed)	,127	,220	,446	,413	
	N	23	23	23	23	23

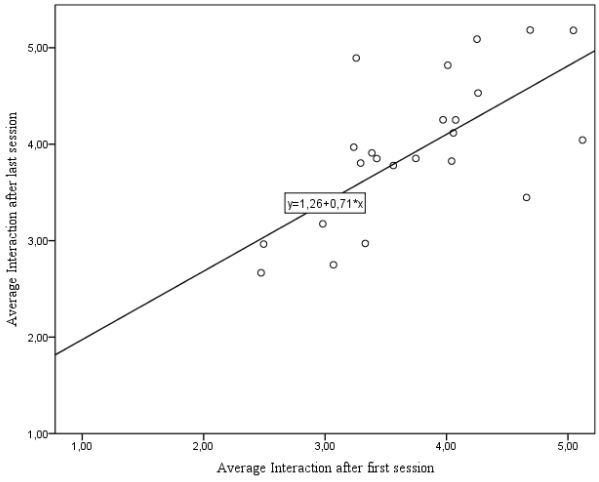
To examine linearity and to look for obvious unusual cases, three scatterplots were produced for each intervention type. Figure 2 shows that there is a positive linear relationship between the average level of interaction after the first session and the average level of interaction after the last session of MT. In other words, lower levels of interaction after the first session of intervention tend to be associated with lower post-intervention levels of interaction, and higher levels of interaction after the first session of intervention tend to be associated with higher post-intervention levels of interaction. Furthermore, it shows that the majority of participants had already high levels of interaction at the beginning of the therapeutical interventions (the majority of values are 3 or higher).

Figure 2. Scatterplot of the relationship between the average level of interaction after the first session and the average level of interaction after the last session in MT.



Similarly, Figure 3 from the control PT intervention shows that there is a positive linear relationship between the average level of interaction after the first session and the average level of interaction after the last session. In other words, lower levels of interaction after the first session of intervention tend to be associated with lower post-intervention levels of interaction, and higher levels of interaction after the first session of intervention tend to be associated with higher post-intervention levels of interaction. Likewise, it shows that most participants had already high levels of interaction after the first session of intervention (the majority of data points have a value of 3 or higher). The comparison of Figure 2 and Figure 3 furthermore shows that participants in the MT condition had slightly higher levels of interaction to start with compared to participants in the PT condition.

Figure 3. Scatterplot of the relationship between the average level of interaction after the first session and the average level of interaction after the last session in PT.



Following, the communicative abilities at baseline were plotted against the communicative abilities post-intervention for both intervention types. For the music-based intervention, a positive linear relationship is observable, indicating that lower communicative abilities at baseline tend to be associated with also lower communicative abilities post-intervention, respectively higher communicative abilities tend to be associated with also higher post-intervention communicative abilities (see Figure 4). Additionally, it's observable that most participants showed moderate communicative abilities, which were roughly evenly distributed.

Figure 4. Scatterplot of the relationship between the communicative abilities at baseline and the communicative abilities post-intervention in MT.

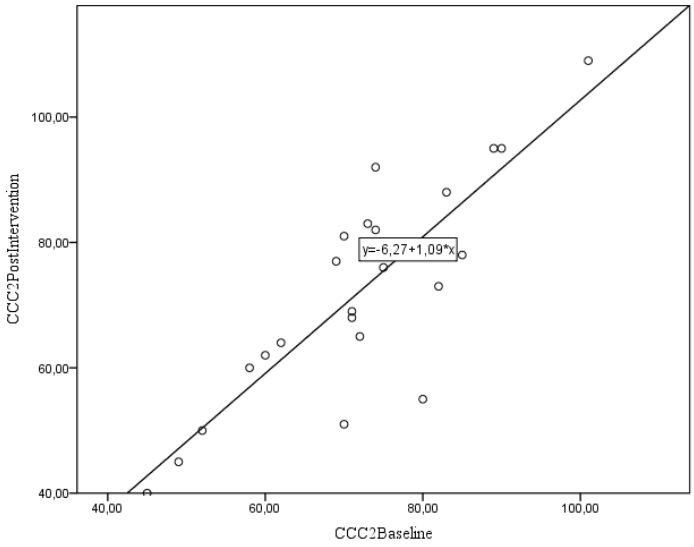
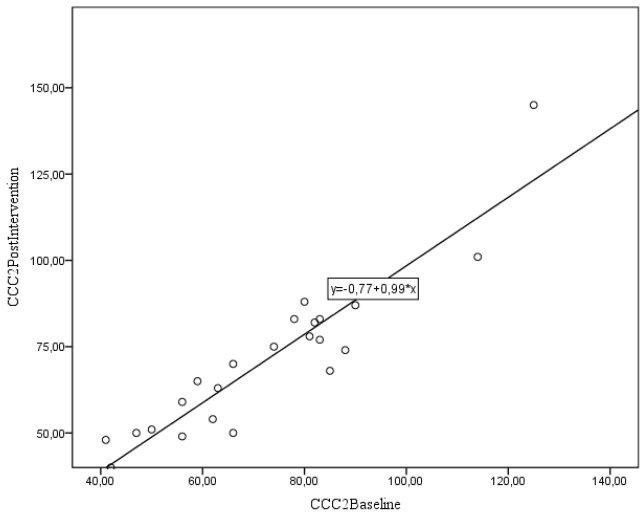


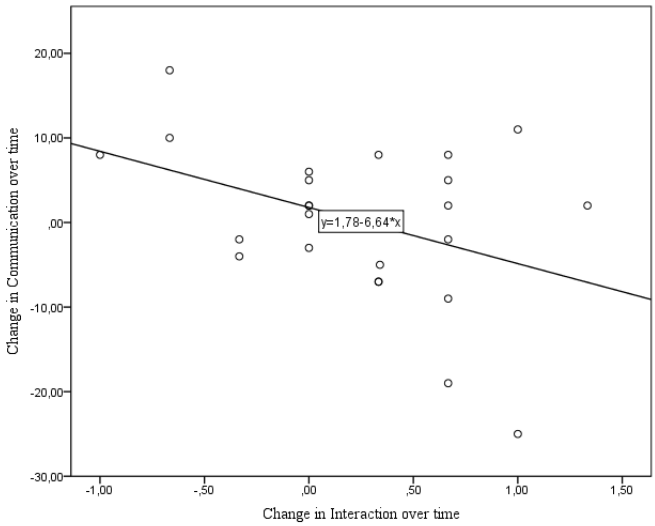
Figure 5 plots the communicative abilities at baseline against the communicative abilities post-intervention for the play-based intervention. As seen in MT, a positive linear relationship is observable, indicating that lower communicative abilities at baseline tend to be associated with also lower communicative abilities post-intervention, respectively higher communicative abilities tend to be associated with also higher post-intervention communicative abilities. Compared to MT, it is apparent that the communicative abilities in the PT intervention, were less evenly distributed with more datapoints accumulating at the lower end.

Figure 5. Scatterplot of the relationship between the communicative abilities at baseline and the communicative abilities post-intervention in PT.



Finally, scatterplots were produced for changes in interaction and changes in communication over the course of both intervention types. Figure 6 for the music-based intervention shows a negative linear relationship, indicating that a 1 unit increase in the level of interaction is associated with a 6,64 unit decrease in the level of communication.

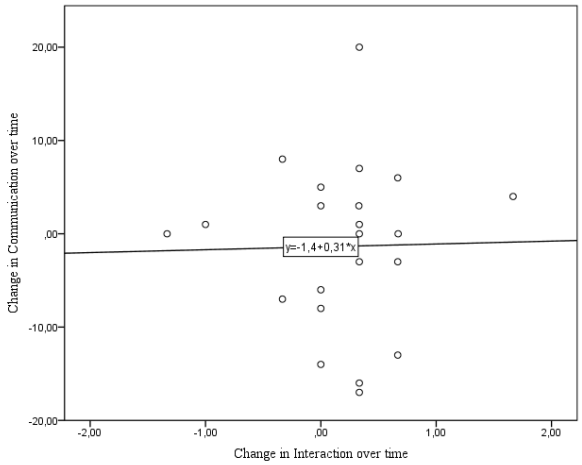
Figure 6. Scatterplot of the relationship between the change in interaction over the course of MT and the change in communication over the course of MT.



The same scatterplot for the play-based intervention, unlike the scatterplot of the music-based intervention, shows a positive linear relationship, indicating that an increase in the level of interaction is associated with also an increase in the level of communication (see Figure 7).

As can be seen from all six scatterplots, relationships were best defined by linear models, showing no obvious unusual cases.

Figure 7. Scatterplot of the relationship between the change in interaction over the course of PT and the change in communication over the course of PT.



The assumption of homoscedasticity was checked for both interventions using a scatter plot of standardized predicted values (*ZPRED) and residuals (*ZRESID). There were no patterns present in the scatterplots of both interventions. The assumption of normality was checked for both interventions with a P-P-Diagram of standardized residues, which gives indication of the distribution form. Additionally, standardized residuals also give an indication of normal distribution and should ideally be between -2,5 and +2,5 (in normal distribution 98,8% of all values are in this range). Standardized residuals in MT had a minimum = -1,71 and a maximum = 1,59. Standardized residuals in PT had a minimum = -1,56 and a maximum = 1,99.

Finally, Cook's distance, a statistical parameter for residuals, was used to assess whether there are any influential cases in the dataset possibly distorting the model. Cook's distance refers to how far, on average, predicted y-values will move if the observation in question is dropped from the data set (Field, 2013). Based on this parameter, one case in the MT based intervention turned out to be an influential case, but was not removed from the dataset, because looking at the visual graphs and reinvestigating this outlier it was evaluated as a legitimate data point. Similarly, one case of distortion could be found for the PT based intervention, but was also not removed from the dataset, due to the same reason. Summarized, all assumptions were met, and no meaningful bias could be found, which allows for the execution of a multiple regression analysis and the generalization of the regression model.

2.2.2. Inferential multiple regression analysis

A multiple linear regression analysis was executed for each intervention type to assess the relationship between changes in interaction and changes in communication after controlling for confounding variables, namely age, gender, and level of autistic traits. In multiple regression analyses, where the model is generalized upon population level, the adjusted R^2 is a better estimator of explained variance in the outcome than R^2.

Table 4 shows that for the music-based intervention, there is a multiple correlation coefficient between the predictors and the outcome variable of R = ,62, and an *adjusted* R^2 value of ,26. Effect sizes in a multiple regression analysis are best reported with Cohen's (2013) f^2. An effect size of $f^2 > 0{,}02$ corresponds to a small effect, $f^2 > 0{,}15$ to a medium effect, and $f^2 > 0{,}35$ to a large effect. The R^2, is converted into an effect size f^2 according to Cohen (2013) with the formula below. Therefore, the model explains about 26 % of the variability in the outcome measure at the population level, which according to Cohen corresponds to a large effect.

$$f^2 = \frac{R^2}{1-R^2} \quad f^2 = \frac{.265}{1-.265} = 0{,}36$$

Furthermore, Table 4 shows the F-test for whether the model is significantly better at predicting the outcome than using the mean outcome (id est no predictors). The F-statistic represents the ratio of the improvement in prediction that results from fitting the model, relative to the inaccuracy that still exists in the model (Field, 2013). The F-statistic is 3,06, p = ,04, meaning that the model significantly improved the ability to predict the outcome variable in comparison to not fitting the model.

Table 4. Music therapy ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.	R	Adjusted R^2
1	Regression	809,206	4	202,301	3,068	,042[b]	,626[a]	,265
	Residual	1252,753	19	65,934				
	Total	2061,958	23					

a. Dependent Variable: Change in Communication over time

b. Predictors: (Constant), Level of autistic traits, Age, Gender, Change in Interaction over time

Significance testing of the individual predictors shows which predictors make a significant contribution to changes in communication. For MT, Table 5 shows that only the predictors changes in interaction and a child's gender were significantly associated with the outcome changes in communication. Changes in interaction with its b = -7,92 and p = ,02 shows a negative relationship with the outcome measure, indicating that as changes in interaction increase by one unit, changes in communication decrease by 7,92 units. This interpretation holds true only if the effects of age, gender, and level of autistic traits are held constant. A child's gender, namely being male, with its b = -10,29 and p = ,03 also showed a negative relationship with changes in communication, indicating that males have a change in communication mean score that is 10,29 units lower than observed in females. In other words, males show less improvements in their level of communication than females. This interpretation holds true only if the effects of changes in interaction, age, and level of autistic traits are held constant. Age and the level of autistic traits did not significantly contribute to the regression model.

Table 5. Music therapy Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	6,067	11,609		,523	,607
	Change in Interaction over time	-7,923	3,344	-,483	-2,370	,029*
	Age	1,400	,876	,292	1,599	,126
	Gender	-10,297	4,509	-,451	-2,284	,034*
	Level of autistic traits	-,086	,097	-,172	-,882	,389

a. Dependent Variable: Change in Communication over time

*p < .05

The F-statistic of the multiple regression analysis for the PT intervention yielded F = ,15 and p = ,96 meaning that the model did not significantly improve the ability to predict the outcome variable in comparison to not fitting the model, which is why no further results of this multiple regression analysis will be reported.

III Discussion

In recent years, MT has gained increasing attention as a promising approach in the treatment of ASD. Music therapy's potential to engage individuals with ASD, targeting various developmental areas has captured the interest of researchers. Despite the growing interest, the evaluation of MT's effectiveness, with its contradictory research findings and methodological limitations remains a challenge.

Because of the mixed and rare evidence regarding overall social improvements in children with ASD undergoing MT, this thesis aimed at investigating how an autistic child's level of social interaction, targeted through improvisational music therapy, relates to an autistic child's level of social communication. Both being strongly linked and important elements of the therapeutical process, further investigation was deemed necessary to better understand the nature of this relationship and the factors that might influence it. Derived from limited previous studies, limited in the sense that they did not assess social interaction as a potentially important outcome predictor, it was believed that gains in the former were also associated with gains in the latter, therefore being best described by a positive linear relationship.

The main findings of the study show that only for the music-based intervention, the regression model significantly improved the ability to predict changes in social communication and explained about 26 % of its variability. A significant relationship between the predictor changes in social interaction, and the outcome variable changes in social communication was observed. Thus, changes in a child's level of interaction were able to predict changes in the child's level of social communication, as was proposed in this thesis' research question. According to Cohen (2013) this corresponds to a large effect, suggesting a substantial impact of the relationship.

This finding is in partial accordance with the findings of Mössler et al. (2019), who emphasized the importance of the therapeutic relationship in predicting social communication skills. The current study likewise found the overarching construct of social interaction to be an effective predictor of changes in social communication skills. Nevertheless, surprisingly this relationship was negative in its nature, contradicting the notion that the improvements in social interaction gained over the course of MT can reduce social communication deficits. Two groups of researchers in the nineties similarly were interested in the predictive value of initiation of joint attention on language development (Mundy et al., 1990; Tomasello & Farrar 1986). The researcher's findings showed that better interaction was in fact associated with better language

ability. Assuming initiation of joint attention to be a sub-exemplar of social interaction and language to be a similar construct to communication, one could expect a similar relationship between social interaction and communication. The opposite relationship was observed in our study, which is why their results could not be supported by our findings. Consequently, the research hypothesis that gains in therapist's subjective reports of a child's level of interaction are able to predict gains in the child's level of social communication rated by educators/ teachers could not be supported by the findings of this study. The relationship seems to be inverse.

The results could partially be explained by the fact, that participants generally seemed to respond very well to interventions and expressed high levels of interaction already at the beginning of both intervention types, with the majority of ratings stating children to be usually/ always interactive and almost no rating indicating a child to be never/ rarely interactive. These observations indicate ceiling effects, which also responds to the impressions of the music therapists, with one music therapist expressing in the supervision meetings that "there are kids in whom we don't feel the autism", and what also led to the discussion as to whether the study tended towards assessing only high-functioning ASD individuals. This problem is also addressed by Marquez-Garcia et al. (2021), who in their systematic review report, that most studies in this regard include moderate-to-high functioning participants and therefore fail to demonstrate effectiveness across the autism spectrum. The finding of high levels of interaction already at the beginning of interventions, was furthermore slightly more pronounced in the music therapeutical intervention, indicating that those participants had also less room to improve their level of interaction compared to participants of the play therapeutical intervention. Also, the communicative abilities in the PT intervention, were less evenly distributed with more datapoints accumulating at the lower end, which adds to why in the PT intervention participants could have had also more room to improve their communicative abilities.

Additionally, also a significant relationship between the predictor gender and the outcome variable changes in social communication was observed, indicating that male participants showed less improvements in their level of communication than females. However, this finding should be treated with caution, as females made up a much smaller proportion of the overall sample (only 20,8 % in the MT model & 13 % in the PT model).

3.1. Limitations

The are several flaws to consider in this study. Firstly, there is scarcity of prior research assessing the predictive value of social interaction skills on communication abilities in the context of ASD. Although the majority of studies assume a strong linkage between social interaction and social communication, only one study could be found, who very similarly investigated sub-constructs of social interaction and their predictive value on social skills, communication, and language (Mössler et l., 2019). However, due to the observational design of the study, the results should be viewed with caution. This limited research base makes it difficult to compare and place the current findings within the broader literature.

Secondly, another substantial problem concerns the large overlap between the two psychological constructs of social interaction and social communication. Both are inherently intertwined and separating their individual characteristics can be very complex. With this background it is clear, why it is problematic to base the assessment of the level of interaction on only three self-designed items, as it was done in the present study. This assessment might not be able to capture the complexity of this construct. In turn, the nature of this unclear demarcation between constructs raises questions about the specificity of the observed relationship and highlights the need for better operationalizations and further investigation. For example, one marker of social interaction often addressed by researchers, which should be assessed in the future is the development of imitation skills, which was shown to increase a child's ability to engage socially (Landa, 2007).

Furthermore, like most studies in this area of research, the study sample was small with $n = 24$ in the music-based intervention and $n = 23$ in the play-based intervention. Additionally, both study samples seemed to consist of mainly high-functioning autistic individuals. Therefore, the findings do not accurately represent individuals with more severe impairments. These points make it questionable to whether the findings should be generalized.

IV Conclusion

This thesis aimed at contributing to state-of-the-art findings regarding the role of social interaction in music-therapeutical interventions for autistic children. Identifying effective predictors of changes in autistic symptoms can be valuable for autistic individuals and their caretakers as well as for clinicians, since its identification provides knowledge on how patients will respond to interventions. While the presented thesis provides insights into the predictive value of social interaction on social communication, it is important to acknowledge the unexpected findings of this research. Although social interaction has been shown to be an important determinant of communication development in ASD, the observed inverse association challenges the previously assumed direction of this relationship. Because findings did not align with the initial hypothesis, interpretations for the unexpected findings had to be explored retrospectively. These interpretations are only of speculative nature. The question remains how interactive factors might contribute to generalized changes in autistic traits through MT, ideally resulting in social improvements for the autistic patient. Therefore, future research with more in-depth understanding of MT's mechanisms and determining factors should aim at addressing the limitations listed above and further investigate the true nature of the relationship between social interaction and social communication. We recommend, larger sample sizes, using more elaborate measurements for assessing the construct of social interaction and to ideally explore a wider range of autistic individuals.

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VI Appendix

6.2 List of Figures

6.1. List of tables

6.3 Monitoring scale

Monitoring scale (filled out by therapists)

Administer, Pre, post and midway through intervention (i.e. in 1st, 6th, 12th session)

Music and Play Therapy Evaluation

Rated on a Likert Scale of 1-5 ranging from Never to Always

	Never	Rarely	Sometimes	Usually	Always	N/A
Interacts with others						
Initiates interaction						
Uses appropriate eye contact						
Shows passive behaviour						
Uses words to communicate						
Uses vocal sounds to communicate (pre-verbal)						
Shows withdrawn behaviour						
Appears unhappy or depressed						
Shows aggression to others						
Has low self confidence						
Shows anxious behaviour						
Has difficulty concentrating						
Expresses feelings appropriately						
Can reflect on own behaviour						

Brief:

1. Goals: original goals, targeted, new goals
2. General comments
3. Ideas for next four weeks