How Passively Listening to Music can Create an Atmosphere for Social Bonding

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***Abstract*— Existing evidence suggests that actively making music facilitates bonding, thereby strengthening our social networks. Whether this is true for passively listening to music is still unclear. Findings of a first (exploratory) study indicated that listening to music did not significantly increase the extent to which people judge others as bonded, contradicting earlier research. Nevertheless, musical reactivity could predict bonding scores, indicating that if emotions are evoked in listeners, they are more inclined to judge others as close. Based on these results, a second experiment was developed to study whether people trust and bond with a stranger more quickly if music is present. Self-report measures were used as well as behavioral measurements, using a version of the 'trust game' in which participants played a computerized opponent which was convincingly presented as real-life player. Results indicated that listening to music increased underlying subjective but not explicit subjective and behavioral closeness. The findings of this study suggest that solely listening to music might not be sufficient to increase feelings of closeness and liking, but rather creates an atmosphere for bonding. Explicit liking and behavioral changes might become apparent when listening to music results in changes in mood, emotions or arousal.**

***Index Terms*—Social bonding, passive music listening, musical reactivity, trust game, evolutionary psychology**

I. Introduction

Music is an important activity for many people (Hargreaves & North, 1999; Tarrant, North & Hargreaves, 2000; North, Hargreaves, O'Neill, 2000) and research exploring the reasons for this importance we appoint to music has been extensive. From an evolutionary psychological approach music is still puzzling. It is not clear how, if at all, it fits in the evolutionary tale of our lineage. Huron (2001) reasons that although evidence is not strong, there is convincing proof that music is an evolutionary adaptation. For example, music is very old, can synchronize group mood and therefore optimize adaptive group efforts, and high involvement in music is not related with negligence or poor survival, suggesting that music is not merely an evolutionary artifact with little or no value. Additionally, music is culturally universal (e.g. Boer & Fisher, 2012), making it plausible that it is an evolutionary adaptation.

More recently, research has been focusing on explaining music in evolutionary terms by looking at it as a tool for building relations and social bonding. In this view, music is functional because it can promote human well-being by facilitating affective communication and human contact (Schuklin & Raglan, 2014) and enhance social interaction by amplifying emotions (Gamble, Gowlett & Dunbar, 2014). Creation of music as well as listening to it is mostly a social endeavor and people often come together to listen or dance to music in groups, in the past as well as in modern times. Indeed, the way in which music is experienced and affects our mood is strongly influenced by the social context, indicating its importance (Hargreaves and North, 1999). Moreover, preliminary research argues that music can help to facilitate bonds and might activate prosocial behavior in humans (Clark & Giacomantonio, 2015, Greitemeyer, 2009; Launay, 2015). Furthermore, influences of music on our social lives are apparent in our tendency to accommodate our music preference to that of others. This conforming behavior seems to be a way to manage our social relationships and is used to fit better within a group and to convey feelings of attractiveness or closeness (Denes, Gasiorek & Giles, 2016). In summary, present research has emphasized the importance of music as a means to manage or encourage social relations (Clark & Giacomantonio, 2015; Launay, 2015; Lonsdale & North, 2011; Schäfer et al., 2016; Schulkin & Raglan, 2014).

A. Music as 'Social Technology'[1]

There appears to be a strong correlation between the size of the neocortex in organisms and the group size they live in (Dunbar, 1989; Dunbar, 1993; Gamble et al., 2014; Kudo & Dunbar, 2001). Consequently, constraints on group size can be explained by the size of the neocortex and its accompanying limitations in information-processing. This is known as the social brain hypothesis (Dunbar, 1993; Dunbar, 1998). Primates use daily grooming time to create social bonds and keep informed about relations in their band. This is possible because their group size is moderate so they have enough time to manage their social lives in this intensive way. Conversely, throughout history the human group size grew too large to use

[1] 'Social technology' is a term coined by dr. M. J. van Duijn in his similarly titled course in the Media Technology program at Leiden University, referring to all tools and inventions that are found to support and maintain social networks in (early) humans. Concordantly, activities such as physical touch, storytelling, the creation of art, fire making, dancing, laughter and music can all be viewed as social technologies.

only physical one-on-one touch to create bonds. In our evolution, brains of our lineage grew larger and so did the groups our ancestors lived in. Other, quicker ways to bond and keep track of each other had to emerge. It is argued that activities such as laughter and storytelling played a role here (Gamle et al. 2014). Similarly, music can be viewed as a 'social technology' that was needed to effectively create and maintain social bonds in our ancestors as groups grew larger, since it can facilitate bonding in large groups of people (Tarr, Launay & Dunbar, 2016). The mechanism behind this bonding effect might be attributed to the release of endorphins. Endorphins are opioid peptides produced by the hypothalamus and function as neurotransmitters. When endorphins are released into the brain the pain threshold goes up and a feeling of reward is induced (Esch & Stefano, 2004). It is suggested that when people trigger endorphins at the same time and place the bond between them is strengthened (Gamble et al., 2014).

According to Dunbar's number (Dunbar, 1993; Gamble et al., 2014), which is based on the size of our neocortex in relation to the rest of the brain, humans now have the cognitive ability to maintain around 150 active social relations. This number has been supported in many ways, for example by showing that the size of a typical African tribe, Neolithic farming village, Christmas card list, tactical unit for Roman Legions, the average number of active Facebook friends, and stable Twitter relations are all approximately 150 (e.g. Ellison, Steinfield & Lampe, 2007; Gamble et al., 2014; Goncalves, Perra & Vespignani, 2011). However, there is scarce evidence that this number can be increased by using tools or technologies to reduce cognitive load (Brashears, 2013; Wellman, 2012). This might be necessary since the pressure of growing societies with sometimes millions of people in one city weighs heavy on our ability to keep informed about the social structures of our group. We simply would not have the time or cognitive ability to keep track of all the connections with everyone to everyone else if we would only have mechanisms like physical touch and laughter at our disposal. From this point of view, making music and dancing might still be important to quickly form bonds within large groups. Kirschner and Tomasello (2010) have demonstrated that young children who engage in music making together show more spontaneous prosocial and helpful behavior towards each other than a carefully matched control group that engaged in identical activities, but without the musical element. Of the children that did not participate in prosocial activities, the children in the music condition provided more verbal excuses than the ones in the control condition, suggesting they were more socially involved. The method used is powerful and adds to the ecological validity of the results, since the games used were cleverly designed so that actual behavior could be coded and the effect of music could be isolated from social interaction in general. Although the study does not reveal which mechanisms underlie the effects (e.g. the musical aspect might have promoted positive mood in children or music might efficiently trigger another evolved characteristic that promotes group cohesion) the findings support the hypothesis that music facilitates bonding and group processes in general. Indeed, Launay (2015) argues that music helps to facilitate bonds and create a social network on which we heavily rely to survive. This is how music, from an evolutionary psychological standpoint, might partly explain the way our ancestors evolved.

B. Music Making, Dancing, Musical Preferences and Bonding

In their book *'Thinking Big'* Gamble and colleagues (2014) mention that making music and dancing have already been found to stimulate bonding between people. Making music, dancing, especially in synchrony, and singing have been found to increase feelings of closeness and willingness to help others, which is potentially mediated by endorphin release (Cohen, Ejsmond-Frey, Knight & Dunbar, 2016; Dunbar, Kaskatis, MacDonald & Barra, 2012; Launay, Dean & Bailes, 2013; Pearce et al., 2016; Reddish, Fischer & Bulbulia, 2013; Tarr et al., 2016; Tarr, Launay, Cohen & Dunbar, 2014; Valdesolo, Ouyang & DeSteno, 2010; Wiltermuth & Heath, 2009).

Like making music and dancing, sharing music preferences with others also seems to increase social closeness. People tend to accommodate their music preference to that of others to convey a friendly attitude (Denes et al., 2016; Schäfer, 2016). Moreover, comparable taste in music can create interpersonal bonds, since it shows a similarity in values (Boer et al., 2011). The finding that people can form bonds through sharing musical preference has been firmly established (e.g. Selfhout, Branje, Ter Bogt & Meeus, 2009; Soley & Spelke, 2016). Speculatively, homophily explains how sharing musical preference can result in a bond between strangers. When people feel similar to another person, they tend to associate themselves with the other and rate them more positively. Among other factors, shared taste in music is a good predictor of likeability (Launay & Dunbar, 2015). Actual similarity is not necessary. A perceived likeness is enough to create feelings of attraction (Montoya, Horton & Kirchner, 2008). In summary, it seems that making music and sharing musical taste are important activities in creating feelings of closeness with others and that endorphin release and perceived similarity (i.e. homophily) are two mechanisms to establish these feelings.

C. Music Listening and Bonding

Surprisingly, the relation between passively listening to music and social bonding is not clear. People listen to music individually and in groups and it is a rewarding activity, but it has been scarcely researched whether it is linked to social connectedness. It has been found that music listening activities in families and with peers contribute to social cohesion and well-being across cultures (Boer & Abubakar, 2014), but in this study the listening has not been experimentally isolated, so it is not clear what exactly added to the social bond. Loersch and Arbuckle (2013) conducted a thorough research with seven studies and made some important discoveries. They found and replicated several times that self-reported musical reactivity, the extent to which music evokes emotions

in an individual, related to and could predict participant's need to belong to a group. Belongingness refers to our very strong, innate desire to be part of a group and a feeling of not belonging can lead to severe (emotional) consequences (Baumeister & Leary, 1995). Moreover, a threat to the group identity of participants, accomplished through a manipulation in response possibilities, resulted in a higher musical reactivity. These outcomes suggest that our ability to respond to music is a form of social cognition and directly linked to social processes and group cohesion. Furthermore, the emotional tone of the music, happy or sad, did not influence scores of participants on social motivation. Although the study by Loersch and Arbuckle (2013) has limitations, such as that it relied solely on self-report measures and did not investigate real-time situations, it provides evidence for music as a social technology and an evolutionary construct to improve social bonding and social processes. Liljeström, Juslin and Västfjäll (2013) complement these discoveries. They measured emotional reactions of participants when they listened to self-chosen or randomly selected music both alone or with a good friend. It was found that listening to music with a good friend or partner causes a stronger emotional response, both for random and self-chosen music. This adds to the understanding of the relation between hearing music and social connectedness, since the way our social group is organized might influence our individual reaction to music. Another study by Edelman and Harring (2015) investigated the role of different musical pieces on the perceived social bond of three walkers in a video. They found that participants who listened to music while viewing the video of the walkers judged them as being an entity more than participants who viewed the same video without music. This finding was not dependent on participant's liking of the music or on the mood of the participant. Additionally, synchrony of the walkers independently added to entitativity scores. This study demonstrates that hearing music enhances the perceived social bond between others in a group. However, whether the increase in perceived entitativity was found because participants assumed the others as having a similar musical preference or because of other factors is not clear. Furthermore, this study explored perceived social bonding between others in a group and did not elaborate upon the link between hearing music and one's own connection to others.

To summarize, different studies point out important findings regarding listening to or hearing music and its relation to feelings of connectedness. Firstly, musical reactivity and social belonging seem linked, suggesting that listening to music is important for group processes and might thus be a favorable trait from an evolutionary point of view. Manipulations of social belonging change musical reactivity which further consolidates the finding that music can be seen as a tool to manage social relations in a group (Loersch & Arbuckle, 2013; Liljeström, Juslin & Västfjäll, 2013). Secondly, listening to music increases the perceived entitativity between group members, indicating that music can influence group cohesion and perhaps the perceived bonds within a social group (Edelman & Harring, 2015).

D. Towards the Current Research

The current research sets out to replicate and follow up on previous studies, by further exploring the bonding properties of listening to music. While earlier research has established that listening to music can enhance perceived bonds within a group, it is not clear how listening to music can influence one's own feelings towards someone else. Additionally, much research has relied mostly on self-report measures to assess social bonding. Other methods should be explored that include actual prosocial behavior that indicates or communicates feelings of closeness to present others to increase generalizability of results. For example, Wiltermuth and Heath (2009) found that students were more cooperative when they participated in joint singing as opposed to no or asynchronous singing, as measured with a public goods game. The carefully designed method used by Kirschner and Tomasello (2010), described earlier, shows another more unconventional way of examining actual prosocial behavior. A last example is the study by Jabob, Guéguen and Boulbry (2010) in which results indicate that listening to music with prosocial lyrics in restaurants leads to tipping more often and more generously than listening to the normal music played or music with neutral lyrics. Such methods have hardly been used in research concerning passively listening to music and social bonding. One instance is the study by Kniffin, Yan, Wansink and Schulze (2017). In this study, the authors investigate how different kinds of music influence cooperative behavior as measured with a public goods game. Results suggest that happy music significantly increases cooperative behavior. This effect can partly be explained by an increase in mood, but the authors conclude there is an independent function of happy music, such as social bonding, that still warrants closer investigation. Similar studies are needed to better explain the role listening to music has played in social processes in the past and, moreover, the role it plays in managing the complex social networks with which people in modern times have to cope.

II. Pilot Study

To be able to formulate specific and meaningful hypotheses a pilot study was conducted first. The pilot study was designed to replicate findings indicating that listening to music increases closeness ratings between others, to further investigate the mediating role of musical reactivity and to explore other factors that might be relevant in studying music listening and social bonding, such as associations with the music, mood and arousal. Specifically, a survey was made and distributed online which included several images of figures. Participants had eight seconds for every image to judge the extent to which the figures on the image liked each other on a slider (0 = not at all, 50 = moderately and 100 = very much), after which the next image would immediately show. Images contained two or more figures that could be drawings or photos of people, shapes and (personified) animals (see Figure 1 for examples). After clicking the link to the survey, participants were randomly assigned to either the music or non-music condition. An introductory text provided

information about the procedure and duration of the survey. Participants were asked to work with a full browser, to close all music applications, to shut out background noise as much as possible and, for the music condition, use headphones or earplugs for the embedded audio. In the music condition Yann Tiersen's 'Comptine d'un autre été', famous from the movie 'Amelie', would play in the background while participants judged the images. This song was chosen since many people are familiar with the song and it seems to evoke strong emotions in listeners. A timer was added to the questions so that the point of the song that was heard in the music condition and the corresponding image on the screen were identical for every participant. Before the target images, three practice rounds were incorporated to account for training effects. After judging the images people were asked to state their age and gender and rate their mood and arousal. In the music condition participants were also asked to name the composer and song, to indicate whether they knew the song, had certain associations with it and to which extent listening to the song was intense for them (slider from 0 = not at all, 50 = moderately to 100 = very much). In total, 47 responses were collected for the music condition and 59 for the non-music condition. Participants for whom too many data were absent, or who did not indicate whether they heard music or not, were excluded from analyses. Finally, responses from 20 and 42 participants were available for the music and non-music condition respectively. Some image ratings were still missing (but no more than four of the fourteen images per participant), because occasionally participants failed to respond within eight seconds. Table 1 shows means and standard deviations of different variables for the two groups of the pilot study.

A. Results and Discussion Pilot Study

Analyses were conducted using IBM SPSS Statistics 23 to examine whether the music and non-music groups differed on a number of variables. Homogeneity of variance was explored through Levene's tests and non-parametic tests were used when appropriate. Groups did not differ on age (Mann-Whitney U(60) = 403, p = 0.791), gender (t(60) = .516, p = 0.609) and general mood (t(60) = .348, p = 0.729). Further analysis revealed no significant difference in sad mood (Mann-Whitney U(60) = 294, p = 0.159) and self-reported arousal (Mann-Whitney U(60) = 319, p = 0.126) between the groups.

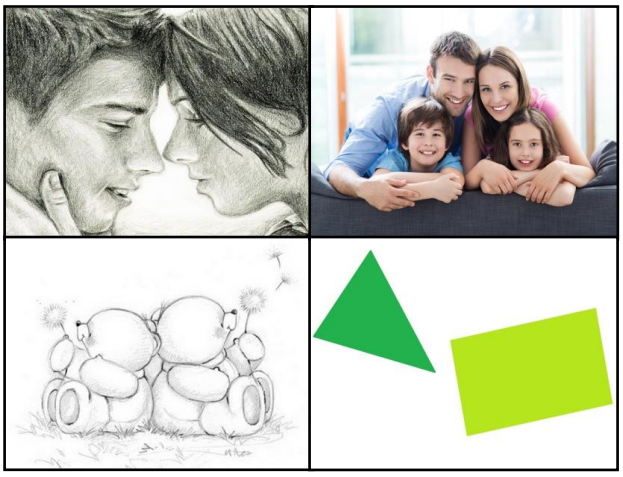

Figure 1. *Examples of images used in the pilot study*

TABLE 1. *Means and Standard Deviations of Pilot Study Variables for Music and Non-Music Group*

	Group		
Variable	***Music***	***Non-Music***	***Total***
Frequency (%)	20 (32.3)	42 (67.7)	62 (100)
Age	29.10 (11.75)	33.76 (17.11)	31.98 (15.47)
Mood	61.40 (15.08)	62.79 (14.49)	62.78 (14.55)
Image Rating	56.42 (5.87)	54.83 (7.15)	55.73 (6.85)
Musical React.	41.25 (28.33)	N.A.	N.A.

Note. Data represent mean values with standard deviation in parentheses, unless indicated otherwise.
Musical React. = musical reactivity.

It was hypothesized that the music and non-music conditions would differ in the extent to which they perceived connectedness between figures on images. More specifically, it was expected that participants in the music condition would rate others as more connected. However, results show no significant difference between the two conditions (t(59) = .860, p = 0.393), leading to rejection of the first hypothesis. Additionally, further exploration did not reveal any relevant difference between the two groups on categories of images such as images where figures were drawn, real, distant, close, people or shapes. These findings suggest that people who hear music do not judge the bond between others as more close or positive than people who do not hear music, contradicting earlier research.

The second hypothesis was that musical reactivity of participants in the music condition could predict the extent to which they judged closeness between figures on images. Linear regression analyses were used to explore this hypothesis. A medium effect of musical reactivity on the rating of images was found with a Nagelkerke R Square of 0.281, indicating that around 28 percent of the variance in closeness ratings in images between participants can be explained through musical reactivity. Results show that musical reactivity can significantly predict closeness ratings in images (t(1) = 2.653, p = .016) with higher musical reactivity ratings corresponding to higher closeness ratings in images, confirming the second hypothesis. It must be noted that although mood alone cannot accurately predict closeness ratings, it does significantly add to the model (t(1) = 2.473, p = .024). Together they have a fairly strong predictive value with a Nagelkerke R Square of .471. Concordantly, musical reactivity and general mood correlate moderately and with marginal significance (Pearson Correlation = -.343, p = .069), which complicates the interpretability of the predictive value of musical reactivity on closeness ratings independent of mood.

In summary, the findings in the pilot study were not in line with existing research, because participants who heard music and participants that did not hear music did not differ in their inclination to judge others (as seen on images) as close. This

suggests that solely listening to music does not influence the perceived bonds between others. Nevertheless, the extent to which emotions were evoked in participants who listened to music seems to correlate with and be able to predict closeness ratings. Consistently, responding emotionally to music seems to increase the tendency to judge others as close. Perhaps music can help to intensify the perceived closeness between others, but only when emotions are elicited in the listener. It must be noted that the sample size is rather small for conducting linear regression analyses. Furthermore, general mood was marginally significantly correlated with musical reactivity and significantly added to model of predicting closeness ratings. The influence of mood on closeness ratings cannot be neglected.

The weight of the findings and the interpretability of the results of this exploratory experiment require a large amount of caution. Firstly, only a small sample size with occasional missing values could be gathered. Secondly, the context in which participants completed the survey was not controlled, since it could be filled in anyplace with access to the internet. Clear instructions and control questions were implemented to make sure the circumstances were somewhat equal across participants, but undoubtedly differences were present that might have influenced the results. Background noise, interruptions, volume of the played music, the type of headphones or earplugs used and the size of the computer screen are some examples of possible confounding factors.

Nevertheless, since this experiment was used for exploratory purposes only, it has some value for the hypotheses and methods for the current study. Firstly, it is important to note that merely listening to music might not have a strong and easily detectable effect on feelings of closeness, as it was not able to increase the perceived closeness between others in this pilot study. Secondly, a mechanism underlying the possible social bonding effects of listening to music might be the extent to which emotions are evoked in listeners. Lastly, measuring actual behavior in addition to self-report measures seems valuable when researching the role music plays in real-life social behavior, since higher ecological validity is attained.

III. Hypotheses

For the present study several hypotheses based on previous research and the conducted pilot study were proposed. The main question is whether listening to music can improve the bond between people and can thus help to manage relationships and, eventually, the complex social networks modern-day people live in. The first hypothesis is that listening to music increases the subjective bond between two people. Secondly, it is hypothesized that not only the subjective bond is strengthened, but that this bond is also expressed in actual trusting behavior. The third hypothesis contains that musical reactivity can help to explain and predict both feelings and behavior of social connectedness, independent of mood.

IV. Methods

A. Design

The current article describes a between-subjects design, with condition, the presence or absence of music, as independent variable. Participants were randomly assigned to a condition at the beginning of participation.

B. Measures

i. Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) was used to measure positive (PANAS PA) and negative affect (PANAS NA) that applied to participants at the time of filling in the questionnaire. Participants are instructed to rate the extent to which a certain emotion is applicable to them at present. The PANAS includes 20 items, e.g. “Interested”, “Upset” and “Nervous”. For this study the questionnaire was divided into two, so that 10 items of the PANAS were filled in at the baseline measure and the remaining items at the end measure. The answers are provided on a 7-point Likert scale (from 1 ‘not or barely’ to 7 ‘very strongly’). The PANAS has been widely used. It has adequate internal consistency (α = .89 for positive affect and .85 for negative affect) and is a valid measure of the constructs it aims to indicate (Crawford & Henry, 2004).

ii. Russel’s Affect Grid

Russel’s Affect Grid (Russell, Weiss & Mendelsohn, 1989) was incorporated to determine general mood and arousal. Participants are presented with a 9x9 matrix. The horizontal axis represents pleasantness and the vertical axis represents arousal, so that participants can rate their mood and arousal with one item by marking the appropriate grid. It shows adequate reliability, convergent and discriminant validity (Holbrook & Gardner, 1993; Larsen, Norris, McGraw, Hawkley & Cacioppo, 2009).

iii. Inclusion of Self in Other Scale

The Inclusion of Other in Self Scale (IOS Scale; Aron, Aron & Smollan, 1992) was used to measure relational closeness. Seven images with two circles representing the self and the other that overlap increasingly, from zero overlap to almost completely overlapped, are presented to participants, who can rate their relationship with another person by choosing the best fitting image (see Figure 2). More overlap between the circles indicates a closer bond. This scale is particularly fitting for the current study, since it can be used for any type of relationship, and not only romantic partners, friends and acquaintances (Dibble, Levine & Park, 2011). Furthermore, Gächter, Starmer

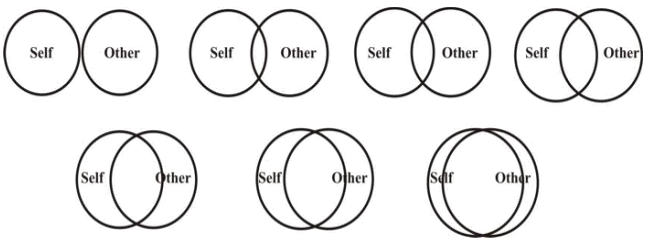

Figure 2. *IOS Scale*

and Tufano (2015) conducted three studies to examine the validity and reliability of the IOS Scale. A very strong convergent validity with a closeness index derived from six other relationship inventories (Spearman correlation of .85) was found. The authors conclude that the IOS Scale is easy to use, highly reliable and a very powerful measure of closeness of relationships.

iv. Subjective Closeness Index

To further explore feelings of closeness of participants several subjective measures were added. Four questions were incorporated for this purpose. The questions were 1 "I liked the person I played the trust game with", 2 "I felt connected to the person I played the trust game with", 3 "The person I played the trust game with was unkind" and 4 "I trusted the person I played the trust game with", and were provided on a 7-point Likert scale (from 1 'no at all' to 7 'very much'). The score for item 3 was reversed and subsequently the sum of all items was used as subjective index for closeness.

An additional measure was added to explore social consequences of the relationship. Participants had to indicate how much money they would give to the other person if they received 100 euro's right now. This measure is not unlike the dictator game (Kahneman, Knetch & Thaler, 1984) in which participants get a variable amount of money and can choose how to split this amount without repercussions of the other player. Nevertheless, scores on this measure should be cautiously interpreted, since the outcomes and the influence of social distance are discontinuous (Charness, Haruvy & Sonsino, 2001; Christoph, 2010; Wu, Leliveld & Zhou, 2011).

v. Musical Reactivity

Musical Reactivity, the extent to which the music evoked emotions in participants, was determined through the sum of two 7-point Likert scale questions, namely "The music felt intense to me" and "The music evoked strong emotions in me". These questions are based on similar items that Liljeström et al. (2013) used in their study. Other questions regarding the pleasantness and familiarity of the music were asked for exploratory purposes.

vi. Trust Game

To measure trust, a version of the trust game (Berg, Dickhaut & McCabe, 1995) was used. Participants are coupled with another player and act either as investor or trustee. Both players get the same endowment. The investor can then invest some or all of the endowment. The invested amount is tripled and given to the trustee. The trustee can now return an amount ranging from zero to the endowment plus the tripled investment.

The trust game is a widely used tool for experimentally measuring trustworthiness and trust. It is a robust and valid measure, but might be limited to trust among strangers (Naef & Schupp, 2009). Many studies have been conducted to assess influencing factors on giving in the trust game. For example, it is important to consider the effect of gender, occupation (student or not), social capital, playing as investor, trustee or both, social closeness and mood (Buchan, Croson & Solnick, 2008; Burks, Carpenter & Verhoogen, 2003; Evans & Revelle, 2008; Glaeser, Laibson, Scheinkman & Soutter, 2000; Johnson & Mislin, 2011).

C. Procedure

A survey was distributed online using university contacts, Facebook and mailing lists. A personalized message with instructions was provided to increase response rates (McPeake, Bateson & O'Neill, 2014) and exercise some control over the condition in which participants would fill out the survey. Participants were compellingly requested to fill out the survey behind a computer or laptop at a quiet moment when there could be no interruptions. The study consisted of three parts, a survey, playing the trust game and the second part of the survey (see Figure 3), and could be completed in around 25 minutes. The first survey included informed consent, PANAS, Affect Grid and an explanation of the trust game. After, a website automatically opened and covered the survey. Participants could resume with the second part of the survey after they had closed the website tab or browser.

i. Trust Game Website

Participants were told that on the website (www.trustinvestmentgame.nl) the trust game was hosted on a global scale by researchers and that they would be connected to a real life player that happened to be active on the server as well. They were also told that the game used sound for which they would need to put on headphones. However, in reality the website was made for the purpose of this study alone and acted the same for every participant. Indeed, Johnson and Mislin (2011) found that playing with a real person or a computer significantly changes the amount that participants send in trust games. Additionally, the prefrontal cortex is less active when players play the game with a computer (McCabe, Houser, Ryan, Smith & Trouard, 2001). Developing a realistic setting is therefore important for valid results. To our knowledge, there has not been a successful attempt to create a trust game with a computer as second player that could convince a majority of participants they were playing against a real person. Since a computer controlled player has advantages regarding experimental control the current method

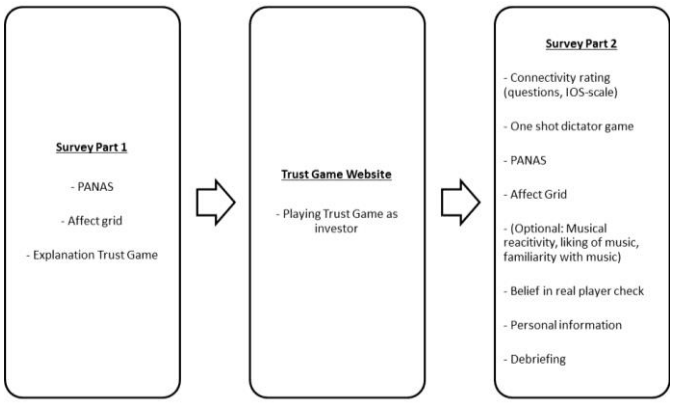

Figure 3. *Measurement times and their contents*

might be a valuable implementation of the trust game.

First, the website opened on the how to play page. Auditory instructions complemented images to explain the rules of the game and to embed sound in a natural way. After the instructions, participants had to press a button to continue to the profile page. Here they could fill in a user name and upload a photo, which the other player they would connect with would be able to see, or choose a default photo as their profile image. This page was included mainly to make the game more realistic and to heighten the participants' belief that they were playing with a real person. However, the username was also used to link the data of the survey with the results in the game by asking participants which user name they would be using before they entered the website. When participants were done setting up their profile they could click a button to go to the next page. Here, they were instructed to wait while they were being connected to another player. Eventually, they would be connected to a fake profile and an image of a young man would show. Consequently, the game started. Ten rounds of the trust game with the participant as investor were played, as earlier research shows that ten rounds is enough for players to construct a cognitive model of the other player and to build a reputation (McCabe, Houser, Ryan, Smith & Trouard, 2001; King-Casas et al., 2005; Tzieropoulos, 2013). The participant had the choice to invest and triple zero, one-third, two-thirds or all of the given points each round and send them to the other player. Randomness in waiting times (e.g. how long the computer waited until it indicated the points that it returned to the investor) was incorporated to make the game more realistic. After each round the results would show and after playing ten rounds the final results were presented. Subsequently, a page indicating that the participant and the other person are disconnected was shown. A 'play again' button appeared for a more realistic feel. However, participants were instructed in the first survey to close the browser after playing one game with ten rounds. If they clicked the play again button participants would enter an infinite loop with the server responding with the message that no persons could be found to connect with, so that participants had no choice but to close the window.

The manipulation was that two versions of the website were created. One encompassed looping background music on all pages and the other did not have music at all. Sounds when clicking a button and when results showed were incorporated so that participants in the no-music condition did not question the use of headphones. The music that was used was Bill Evans' 'Like Someone in Love' from the 'Time Remembered' album, in which he plays solo piano. This music was chosen since the composition is complex, masterfully executed and contemplative, so that it is likely that emotions are evoked in listeners. Furthermore, the music complements the trust game in a way that the attention is not immediately drawn to the music, reducing its perceived role in the experiment.

A difficulty was that we could not predict how much participants would invest each round, so to determine the amount of points returned by the preprogrammed trustee a formula was written to return a percentage of the tripled investment. Consequently, all the participants were treated the same in a relative way, but the amount of returned points depended on their investment choices. Higher investments were rewarded with higher percentages of return. More specifically, participants that invested zero, one-third, two-thirds or all of the endowment were returned 0%, 20%, 33% and 42.5% of all the points available to the trustee respectively. These percentages are based on the research by Launay, Dean and Bailes (2013), but made to work for any endowment. In the tenth and last round, the computer was programmed to return zero points regardless of the investment, since this is a very common strategy among human players within the trustee role. Figure 4 clarifies the return process for the first nine rounds of the trust game. If absolute return amounts would have been used it would not have been possible to give back more than the endowment, since participants could have invested zero points. This would be unrealistic and likely have resulted in low likability of the fake player.

When participants had closed the trust game website the survey would appear again, where they were able to continue to the second part. This included subjective closeness questions, IOS Scale, PANAS, Affect Grid, musical reactivity and music liking questions, checks to determine the belief of participants that they were playing with a real person, personal information and debriefing. Lastly, participants could add their email if they wanted to participate in the raffle for the gift card and were thanked for their invested time.

D. Overview of Analyses

Hypothesis one was that listening to music increases the subjective bond between two people. For this hypothesis two unpaired t-tests between participants in the music and non-music condition were used to compare average IOS Scale scores and subjective closeness index scores.

The second hypothesis involved the difference in trust as measured through the trust game. An unpaired t-test was conducted to compare average invested amounts in the two groups. Additionally, the same test was conducted for the money given in the dictator game in the second part of the survey to further explore the impact of music on social decisions and cooperation.

Lastly it was expected that musical reactivity can predict social closeness. Linear regression was used to investigate the

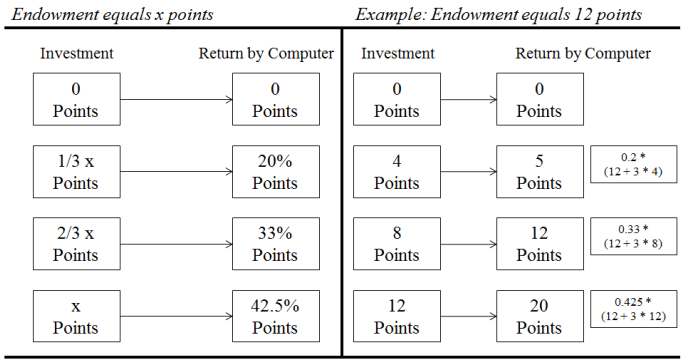

Figure 4. *Computerized return of the first nine rounds based on the participant's investment*

relationship between musical reactivity and subjective closeness ratings (i.e. scores on the IOS Scale). The same procedure was used to explore the relation between musical reactivity and invested amounts in the trust game. All analyses were completed with the use of SPSS 23, a two tailed significance level of $\alpha = .05$ was maintained. Non-parametric tests were used if appropriate.

V. Results

The survey and trust game were completed by 65 participants. Participants with missing data, who reported difficulties with the website or who heard no music despite being in the music condition were excluded from analysis. Finally, data of 55 participants were available of which 26 in the music and 28 in the control condition.

For these 54 participants 29 (53.7%) were male and 25 (46.3%) were female and age ranged from 18 to 63 (M = 25.52, SD =7.73). Means and standard deviations of the study variables are depicted in table 2 for the two groups. Homogeneity across groups was examined with the Levene statistic. Equal variance was assumed for age (Levene statistic(1, 52) F = .048, p = 0.827), gender (Levene statistic(1, 52) F = .0522, p = 0.473), initial positive mood (Levene statistic(1, 52) F = .018, p = 0.894), initial negative mood (Levene statistic(1, 52) F = .029, p = 0.865) and initial arousal (Levene statistic(1, 52) F = .137, p = 0.712). Further testing revealed no significant differences between the groups regarding age (F(1, 52) = .069, p = 0.794), gender (F(1, 52) = 0.268, p = 0.607), initial positive mood (F(1, 52) = 0.840, p = 0.364), initial negative mood (F(1, 52) = .089, p = 0.766) and initial arousal (F(1, 52) = 0.104, p = 0.749).

TABLE 2. *Means and Standard Deviations of Variables For Music and Non-Music Group*

	Group		
Variable	***Music***	***Non-Music***	***Total***
Frequency (%)	26	28	54
Age	25.81 (7.56)	25.25 (8.01)	25.52 (7.73)
Mood Positive[a]	22.81 (5.28)	21.50 (5.19)	22.13 (5.23)
Mood Positive[b]	18.46 (5.80)	19.64 (4.09)	19.07 (4.97)
Mood Negative[a]	9.31 (4.41)	9.68 (4.69)	9.50 (4.52)
Mood Negative[b]	11.88 (5.39)	11.79 (5.21)	11.83 (5.25)
Arousal[a]	5.73 (1.87)	5.89 (1.83)	5.81 (1.83)
Arousal[b]	5.31 (1.80)	4.82 (1.70)	5.06 (1.71)
IOS*	2.27 (1.04)	1.75 (0.75)	2.00 (0.93)
TG Investment[c]	97.54 (44.53)	96.26 (38.82)	96.89 (41.32)
SCI[c]	14.50 (2.74)	14.79 (1.73)	14.65 (2.26)
Musical React.[c]	5.44 (2.76)	NA	NA

Note. Data represent mean values with standard deviation in parentheses, unless indicated otherwise.
Musical React. = musical reactivity, SCI = subjective closeness index, TG = trust game.
[a] Values reflect baseline measures
[b] Values reflect end measures
[c] Values reflect sum scores
* Group means are significantly different with $p < .05$

A. Listening to Music and Social Bonding

Hypothesis 1 was that listening to music would increase the self-reported feelings of closeness between the players in the trust game. An unpaired t-test was conducted to compare IOS scale ratings between the two conditions. IOS scale ratings in the music group were significantly different (t(52) = 2.087, *p* = .043) with higher ratings in the music condition, which was in line with the first hypothesis. However, no significant difference in the subjective closeness index ratings was found (t(52) = .454, *p* = 0.652), contradicting this hypothesis. Surprisingly, there seems to be no correlation (Pearson Correlation = .018, p = 0.898) between IOS scale ratings and other self-report measures of closeness in this sample. Pearson correlations of study variables are shown in table 3.

TABLE 3. *Correlations Between Measures of Mood, Closeness, Musical Reactivity and Trust*

Variables						
	PA	*NA*	*TG*	*IOS*	*SCI*	*MR*
PA	-					
NA	-.077	-				
TG	.047	0.142	-			
IOS	0.159	-0.058	0.362*	-		
SCI	.047	0.156	-0.178	.018	-	
MR	.021	.078	-.047	-0.072	0.333	-

Note. PA= positive affect, NA = negative affect, TG = trust game investments, IOS = IOS scale ratings, SCI = subjective closeness index, MR = musical reactivity.
* $p < .05$

B. Listening to Music and Trust

The second hypothesis contained that listening to music would increase behavioral closeness as measured through giving in a trust game. Of one participant no data were available. Consequently, an unpaired t-test with 53 participants was conducted to examine differences between the music and control conditions. The second hypothesis was rejected, since no significant difference was found (t(51) = .112, p = 0.912). Accordingly, participants in the music condition did not intend to give more money to their counterpart than participants in the control condition (t(52) = .448, *p* = 0.656). Further exploration revealed a significant correlation between invested amounts in the trust game and IOS scale ratings (Pearson Correlation = 0.362, $p < .05$), but not with the subjective closeness index (Pearson Correlation = -0.178, p = 0.201). Note that males invested more than females (t(51) = 2.233, p = .030) which is in line with existing research (Buchan et al., 2008).

C. Musical Reactivity and Social Bonding

Lastly, it was hypothesized that musical reactivity can predict feelings and behavior indicating social bonding. Two linear regression analyses were conducted to investigate the extent to which musical reactivity scores could predict subjective closeness as measured through the IOS scale and behavioral closeness as measured through the sum of investments in the trust game. Contradicting the hypothesis, no significant effect on IOS ratings was found (F(1, 24) = .121, p = 0.731), indicating that musical reactivity could not predict subjective feelings of closeness. Similarly, musical reactivity could not predict amounts invested by participants (F(1, 24) = .052, p = 0.822). These findings oppose the third hypothesis that musical reactivity and social bonding are linked.

D. Belief in a Real Player

The current method was developed as a means to overcome difficulties concerning the trust game and playing against a computer. Specifically, participants often feel they are playing a computer which makes them behave differently (Johnson & Mislin, 2011). The extent to which the website was able to fool participants into believing they were playing a real player was explored. Participants were asked to respond with 'yes', 'maybe' or 'no' to the statement: "I believe I was connected with a real player". When 'maybe' is interpreted as a 'yes' 52.8% of the participants believed they were playing with a real player and 47.2% did not. Additionally, participants were asked the extent to which they believed they were coupled with a real player on a 7-point Likert scale and the average across participants was 2.92. No significant differences between conditions was found regarding belief in a real player.

VI. Discussion

The present study aimed at investigating the social bonding effects of listening to music and the potential role musical reactivity plays in this relation. Mixed results for the first hypothesis were found, since listening to music increased feelings of social closeness when measured through the IOS scale, but not when assessed with the other subjective closeness index used in this study. Secondly, listening to music did not influence behavioral measures of social closeness as measured with a trust game, contradicting the second hypothesis. Lastly, results concerning the third hypothesis revealed that musical reactivity could not predict both subjective and behavioral measures of closeness.

The mixed results concerning the effect of listening to music on social closeness are puzzling. It is contradicting that measurements of the IOS scale and the subjective closeness index did not correlate. Possibly, the IOS scale is a more fit measure of closeness for this study, since the interaction with a counterpart was short and with a complete stranger. Accordingly, the subjective closeness index used in this study might be too elaborate for this setting, while the IOS scale is particularly attuned to these situations (Naef & Schupp, 2009). The extensive evaluation of the IOS scale by Gächter and colleagues (2015) solidifies this assumption. Since trust and social closeness have been found to correlate (Gummerum & Keller, 2008; Murray, Derrick, Leder & Holmes, 2008; Salazar, 2015) it seems reasonable to assume that IOS scale ratings in this study are more accurate than other measures of social closeness. Indeed, a significant correlation was found between the IOS scale and invested amounts in the trust game, while no such correlation exits between invested amounts and the subjective closeness index. The IOS scale ratings are significantly different between the conditions, suggesting that listening to music facilitates feelings of closeness and similarity. However, since more rational questions regarding liking did not increase by listening to music, it is plausible that listening to music can create an atmosphere for openness toward and assimilation with others, but is not sufficient to increase explicit liking and friendship. Listening to music has indeed been found to influence the perceived atmosphere in various settings (Garlin & Owen, 2006; Wilson, 2003). Our finding extends preliminary research by proposing that passively listening to music might be a 'tool' to create an atmosphere for bonding, but is not sufficient to actually bond like music making, singing, dancing and sharing music preferences. This property can partly explain the extensive role of listening to music in our society. Managing our social relationships is a daunting task now that we tend to live with many people in vast cities and contact is easily established via the internet and, frankly, inescapable. Keeping track of direct and indirect relationships is cognitively demanding and establishing and maintaining relations takes up much of our time. Passively listening to music does not relieve us from cognitive challenges, but might help to reduce the time needed to bond with others, leaving more time for other activities. Hypothetically, this mechanism was present in our ancestors as well, making their groups more cohesive and creating time to engage in other activities. Clearly, this bonding property of listening to music is not the only function. Other functions that are more apparent, at least in modern times, might exist concurrently. Indeed, according to self-report measures people tend to attach considerable importance to mood regulation and self-actualization functions of music (Hargreaves & North, 1999; Lonsdale & North, 2011; North et al., 2000; Schäfer, Sedlmeier, Städtler & Huron, 2013; Tarrant et al., 2000).

Secondly, results indicated no effect of listening to music on trust as measured through investments in the trust game. It is worth mentioning that IOS scale ratings and trust correlated significantly and IOS scale ratings were higher in the music condition, which could indicate a small, yet insignificant effect, on trust game investments as well. However, in the current study, listening to music increased underlying subjective but not behavioral closeness. This is in line with earlier reasoning that listening to music can create an atmosphere for bonding, but is not adequate for increasing actual behavioral expressions of liking or closeness. Possibly, trust and its accompanying behavior is only established in a later stage in a relationship. Indeed, Delgado-Márquez, Hurtado-Torres and Aragón-Correa (2012) observed that in a trust game situation people tend to invest more to friends of friends than to strangers, and even more to direct friends. Playing the trust game for ten rounds might be enough to build a cognitive model of the other and a reputation (McCabe et al. 2001; King-Casas et al., 2005; Tzieropoulos, 2013), but not to build even a rudimentary friendship. Consequently, although it might make bonding happen earlier and more easily, solely listening to music does not seem to be able to establish a relationship in which there are measurable increases in behavior indicating closeness. A noteworthy difficulty is that the capacity of the trust game to measure trust is limited. Even though it is unlikely that factors like gender, attraction and occupation influenced the results, since the groups were well balanced, confounding variables may play a role. Indeed, investments are highly dependent on personality (Evans & Revelle, 2008), also assess economic decision making qualities, and might measure attitudes and views on trust,

more than trusting behavior itself (Ben-Ner & Halldorsson, 2010). This indicates that investments in the trust game might partly overlap with, but not be a precise behavioral measure of closeness.

Thirdly, results regarding the relation between musical reactivity and subjective and behavioral closeness were not in line with expectations based on existing research and the pilot study. The extent to which emotions were evoked in listeners could not predict both subjective closeness and investments in the trust game. However, it seems premature to discard musical reactivity as a mechanism for social bonding. Indeed, while participants liked the music, on average 4.52 on a 7-point Likert scale, they had low musical reactivity ratings. Speculatively, listening to music can intensify concrete feelings of liking and closeness, but only when emotions are elicited in the listener, which was not the case in this study. Accordingly, results suggested no significant changes in mood or arousal. This presumption is in line with findings by Kniffin and colleagues (2017) where people cooperated more while listening to happy music and an increase in mood was perceived. Perhaps the music in the current study was too much in the background, so it went somewhat unnoticed and did not evoke strong emotions. Therefore, it is desirable to experiment with different songs and styles of music, so that more emotions are elicited in the listener. Additionally, assessing musical reactivity through skin conductance and heart rate in conjunction with subjective ratings might result in a more precise measure of musical reactivity. Nevertheless, alternative mechanisms that can stimulate bonding through listening to music cannot be ruled out. Endorphin release, a mechanism that has been found to contribute to the bonding effect in music making, singing and dancing (Dunbar et al., 2010; Pearce et al., 2016; Tarr et al., 2016), is unlikely to cause bonding when passively listening to music, since it does not typically involve muscle activity (see also Gamble et al. 2014, p. 60, 157). Conversely, it might be that listening to music heightened a sense of similarity between participants and their counterpart. Following this line of reasoning, Edelman and Harring (2015) found that participants assumed people in a video to like the music that was played with the video. Perhaps, the participants in the current study, who indicated to like the music, had the same presumption and thus experienced a shared taste in music, which was not possible in the control condition. It seems reasonable to assume participants expected their partner to hear identical or at least similar music, since they were playing the same game on a remote website at the same time, with no indications that the music would be dissimilar for different players.

Lastly, it was found that about half of the participants were fooled into believing they were playing a real player in the trust game by using an external website where they had to set up a profile and waiting times were incorporated. This is similar to the percentage found in regular laboratory settings (e.g. Launay et al., 2013). Using belief in a real player as grouping variable did not reveal differences in self-report ratings of closeness or trust game investments, suggesting that people treat the computer on this website as a human regardless of their beliefs, though this opposes previous research (Johnson & Mislin, 2011; McCabe et al. 2001). Another explanation is that people are actually grasping at straws when they are playing the trust game, which is in line with complications of the trust game mentioned earlier. Accordingly, Burton-Chellew and West (2012) found that people playing the public goods game cooperate on similar levels, even when they are explicitly told that a mathematical function determines their return. Likewise, results of a study by Kümmerli, Burton-Chellow, Ross-Gillespie and West (2010) indicate that people are reluctant to fully cooperate or always deny profits for others. This unwillingness to use extreme strategies can clarify behavior in public good games and shows that they are rather unusable when trying to study real-life behavior of trust, cooperation and social distance (see also Harrison & El Mouden, 2011). Similar difficulties are expected to be present in other economic games like the trust game, strengthening the proposition that differences found in trust game behavior are not the result of social motivations such as trust, cooperation and closeness, but might reflect other underlying psychological drives that are not specifically measured. The thought that people's behavior during economic games is quite accidental with regard to the constructs it aims to measure, and that these games are, as of yet, impracticable for explaining real-life trusting and cooperative behavior is alarming. Alternative experimental measures integrating real-life cooperation are needed. However, with regard to the trust game website used in this study, it shows to be an adequate alternative to strict laboratory settings, in which it is easy to implement manipulations while controlling other factors, but does not add to already established procedures of the trust game. Nevertheless, it might be worthwhile to attempt adjustments to improve the effect to fool people into believing they are playing a real player.

A. Limitations

Admittedly, the current study contained several limitations. A weakness was the method of distribution of the survey. Since a link was sent through different channels, and receivers were able to participate anytime and place they wanted, limited control on the environment in which the survey and trust game were completed was available. Although the message accompanying the link and instructions in the survey emphatically requested participants to fill out the survey at a quiet moment when they could take their time and not be disturbed, no supervision was present. This distribution might have influenced the results somewhat. Nevertheless, it was assumed that it would not cause differences between the conditions and tests regarding homogeneity confirmed this to some extent. Sharing the survey in this way was chosen to increase the number of participants and because only limited time and effort could be asked from participants, since no funds were available. A second limitation was that the number of participants was not great enough to include a third condition with different music. This restricted the interpretation of the effect of listening to music to jazz piano music. Elaborating upon this, it is conceivable that different kinds of music do not only have a greater effect on musical reactivity and mood, but directly on social behavior and

bonding as well. Certain genres are played more in, and are therefore perhaps more strongly associated with, social settings and connecting with others. Jazz piano music could for most people be regarded as music for individual occasions (e.g. during relaxation, studying or elevator rides) in comparison to, say, dance music, which is frequently played in clubs and at parties. Perhaps a more explicit bonding effect is observed when people are passively listening to music that is often played in social situations. In total, it would have been interesting and valuable to investigate other genres, the difference between music styles and the effect of music including lyrics. Thirdly, as mentioned earlier, ten games of the trust game might not have been adequate in establishing a social bond between participants and their counterpart. Speculatively, this might have made it hard to assess differences in closeness or trust between the two experimental groups, since the threshold for expressing any prosocial behavior regarding their partner was not attained. Other experiments involving real-life cooperation in pairs might have been better at creating a bond in which at least rudimentary prosocial behavior occurs and has the benefit of avoiding the complications of economic games. Consequently, the effects of listening to music might become more clear. Lastly, it was not possible to include a baseline measure of connectivity or closeness in this study set-up. Although group differences could still be determined, the direction and magnitude of changes in feelings of closeness are not clear.

B. Future Research

Future research should more thoroughly investigate the relation between passively listening to music and social bonding. More specifically, further investigation of the finding that listening to music can create an atmosphere for bonding, but can only increase actual feelings of closeness when mood changes or emotions are elicited in listeners is needed. Studies concerning this topic should include various music genres to investigate what quality of music is important to create this atmosphere and invoke emotions. It might also be interesting, for example, to explore the difference between live and recorded music. Additionally, more research regarding mechanisms underlying the effects of listening to music on bonding, such as perceived similarity and musical reactivity, is warranted. When more clarity regarding listening to music and social bonding is achieved, it will help us understand the ways in which we use it to manage our relationships and social networks.

VII. Concluding Remarks

Taken together, the findings of this study suggest that passively listening to music might not be enough to directly increase feelings of closeness and liking, but rather create an atmosphere for bonding. More specifically, it seems that music can create a setting for people to be more open to and 'merge' with others. This could explain differences between scores on questions regarding liking and the IOS scale, a more heuristic measure of closeness. Taking the results of the pilot study into consideration, it would appear that concrete increases in liking and behavior that signify closeness are only apparent when listening to music results in changes in mood, emotions or arousal (see also Kniffin et al. 2017). Nevertheless, if listening to music has the property to create an atmosphere for bonding, this has implications for application in social interaction. This seems especially true in situations where getting acquainted with (unfamiliar) others or connecting with friends is important, such as in pubs and restaurants, and during networking events, dating situations and team building exercises. Hopefully, the results of the present study will stimulate researchers to investigate the bonding effect of passively listening to music and its underlying mechanisms, particularly musical reactivity and perceived similarity, more extensively.

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