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Rory Allen, Elizabeth Hill and Pam Heaton

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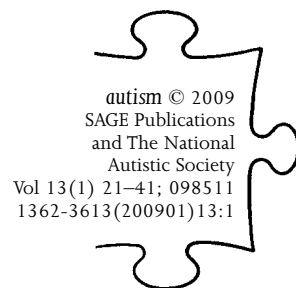
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'Hath charms to soothe . . .'

An exploratory study of how high-functioning adults with ASD experience music



RORY ALLEN Goldsmiths, University of London, UK

ELIZABETH HILL Goldsmiths, University of London, UK

PAM HEATON Goldsmiths, University of London, UK

ABSTRACT Semi-structured interviews were conducted with 12 high-functioning adults on the autism spectrum, in order to examine the nature of their personal experiences of music. Consistent with the literature on typically developing people's engagement with music, the analysis showed that most participants exploit music for a wide range of purposes in the cognitive, emotional and social domains, including mood management, personal development and social inclusion. However, in contrast to typically developing people, the ASD group's descriptions of mood states reflected a greater reliance on internally focused (arousal) rather than externally focused (emotive) language.

KEYWORDS
high-functioning autism; mood; music

ADDRESS Correspondence should be addressed to: RORY ALLEN, Department of Psychology, Goldsmiths, University of London, New Cross, London SE14 6NW, UK. e-mail: r.allen@gold.ac.uk

Over the last two decades, an increasing number of experimental studies have explored an association between autism and absolute pitch, autism and savant skills in music, and autistic traits in musicians with absolute pitch (Bonnell et al., 2003; Brown et al., 2003; Heaton, 2003; 2005; Heaton and Wallace, 2004; Heaton et al., 1998; 1999b; 2007; Mottron et al., 1999; Nettelbeck and Young, 1996; Treffert, 1988; Young and Nettlebeck, 1995). However, many of these studies report findings from prespecified subgroups of individuals, test specific components of music (e.g. absolute pitch), and do not therefore throw light on the nature of musical experience in the wider ASD population.

Experimental findings that generalize to broader populations of individuals with ASD have explored sensitivity to emotion in music. For example, Heaton et al. (1999a) showed that children with ASD understood the affective connotations of musical mode sufficiently well to be able to pair schematic representations of happy and sad faces with extracts of music in

major and minor keys. In a more recent investigation (Heaton et al., 2008), typically developing 4- to 10-year-old children, children and adolescents with Down syndrome and those with ASD matched musical extracts with pictures denoting a range of affective and non-affective scenarios; unimpaired performance was again noted in the ASD group. However, a limitation of both of these designs is that they specifically tested the ability to make conventional musical associations, and provided only limited insights into the nature of the participants' personal experience of music.

Other, non-experimental, investigations into the broader impact of music in people with autism have explored the value of music in a therapeutic context. Recent studies (Boso et al., 2007; Kern et al., 2007) have shown benefits, and a meta-analysis (Whipple, 2004) claimed that music therapy is demonstrably effective in improving the condition of children and adolescents with autism. For example, Wigram and Gold (2006, pp. 540–1) found some evidence of positive effect on interpersonal communication, reciprocity and relationship-building skills. However, a number of methodological criticisms have been made of these studies (Accordino et al., 2007; Kaplan and Steele, 2005) and their conclusions should therefore be treated with some caution.

Recent findings based on interviews and other self-report measures shed light on how typically developing (TD) people engage with music in their everyday lives (for example Batt-Rawden and DeNora, 2005; DeNora, 2002; Lamont, 2006; North et al., 2004). These studies suggest that it would be fruitful to use alternative, non-experimental approaches to studying musical engagement in people with ASD, at least in cases where the well-documented semantic and pragmatic difficulties with language in autism (for example, Jolliffe and Baron-Cohen, 1999) do not make self-reporting of musical experience impracticable or unreliable. We aimed to limit these effects by confining our study to high-functioning adult participants, and by using a semi-structured questionnaire with an open-ended interview approach. Previous research has established that this methodology is appropriate for adults with high-functioning autism or Asperger syndrome (Hill et al., 2004b, Berthoz and Hill, 2005). Whilst an exploratory approach is unusual in psychology research, it has been recommended where an area has not previously been explored in depth. As Wilkinson (1999) states: 'if exploration were not disguised in hypothetico-deductive language, then it might have the opportunity to influence subsequent research constructively'.

Whilst our study does not have a matched control group, extensive prior qualitative research into the nature of the musical experience in non-autistic populations has been carried out, and provides a context for our analysis. Advantages of our design are that it is not limited by preconceptions or prior hypotheses, and conforms to standards of validity in qualitative research.

Aside from that relating to music therapy, there has been little or no published work concerning the subjective experiences of music in individuals on the autism spectrum.

The objective of the present study was to investigate the nature of the subjective experience of music in adults with ASD, exploring where our sample might be situated on the continuum of musical appreciation and understanding.

Method

Participants

Twelve high-functioning adults (10 men and two women; ages 21–65, mean 41, SD 16) with diagnoses on the autism spectrum (nine with Asperger syndrome (AS), three with autism) took part in the study. The design had been approved by the Goldsmiths College Psychology Department ethical committee, and all participants gave written informed consent. This was a convenience sample: participants had previously taken part in other autism-related research conducted by colleagues at Goldsmiths College on non-musical topics. Participants were not recruited for their musical abilities or experiences.

Design: development of semi-structured questionnaire

The research question involved exploring the nature of the musical experience in autism. As autism is a developmental disorder, our questionnaire (Appendix 1) focused on the early development, as well as the current nature, of participants' musical experience. This led logically to a division into two parts: 'autobiographical memories' relating to music, and 'current reactions' to music. The specific questions in each section were suggested by our clinical experience and other music-related questionnaires. We added certain questions in order to explore the possibility suggested by other authors that emotional deficits in autism would generalize to music. Two other questions, about the evocation of images and the importance of lyrics in songs, were suggested by spontaneous comments by two early participants mentioning these aspects. The addition of items to semi-structured questionnaires as research progresses is acceptable in the grounded theory methodology within which the research was conducted (see below).

Responses to the questionnaire were analysed using a qualitative data tool, NVivo7 (QSR, 2006). The method of analysis was modelled on grounded theory, as developed from the work of Glaser and Strauss (1967) and based in particular on the methods for applying grounded theory to psychological research described in Pidgeon and Henwood (1997). We felt

that a qualitative approach was well suited to the exploratory nature of our primary question: 'How do high-functioning adults with ASD experience music?', as per Losch (2006) and Pidgeon and Henwood (1997).

The method of analysis was divided into the phases of initial analysis and coding, core analysis involving the subdivision of the initial categories, and the formation of 'outcomes': relationships, definitions and models (Pidgeon and Henwood, 1997). Bazeley (2007) suggests asking questions of the text to generate nodes: who, what, when, why etc. In our initial analysis of the raw transcripts, two clear categories emerged, dealing broadly with the questions 'why' and 'what'. We chose the term 'motivations' to represent the reasons or aims explaining 'why' individuals decided to listen to music, and 'characteristics' to represent the type of music which was chosen to achieve those effects ('what'). All transcribed interviews were initially coded into two corresponding tree nodes; one containing all 'motivations' passages from the interviews, and one including all the 'characteristics' passages, each node subdivided by participant (for details of how the coding process works in NVivo, see Gibbs, 2002 or Bazeley, 2007).

We then separately examined these motivations and characteristics nodes, searching for themes within these subcategories that were common to more than one individual, and creating subnodes for these emerging themes. This process of forming subnodes can be carried out electronically in NVivo7. It involves becoming thoroughly familiar with the raw transcript material, noting what appear to be common themes among two or more individuals, encoding the material according to these themes, and, by an iterative process, re-examining the coded material and raw transcripts to see whether the themes appear to be consistent with one another and to divide up the material in a way that appears meaningful. The process ends when the categorizations appear to be stable and to include all material of significant interest in the raw transcripts. Details of the definitions finally adopted for inclusion in nodes, and an extensive set of quotes showing typical participant comments within each node, are available on application to the authors.

In order to see whether early musical training and experience were relevant, we also administered a questionnaire assessing levels of musical experience, based on a child version previously validated by Heaton et al. (2007): see Appendix 2.

Procedure

In order to accustom participants to the interview situation by using a comparatively unthreatening closed-question routine, we administered the early musical experience questionnaire first. We then proceeded to the semi-structured interview, recording this part (with participants' consent) on a minidisk machine for subsequent full transcription.

Results

Development of musical interests

The questionnaires and interviews suggested that with a couple of exceptions, the participants fell into two categories, with five individuals in each. The first, which we refer to as the ‘classical’ group, acquired a liking for music at a relatively young age, and now enjoy listening to, and in some cases also playing, primarily classical music. The second, the ‘pop’ group, comprises those whose interest in music blossomed when they discovered pop music in their teenage years, having previously shown little or no interest in music. Two participants did not fit into either group, and were ‘outliers’ in a qualitative sense. Of these, one was interested in music only as an accompaniment to films; the other was interested mainly in the narrative structure and dramatic qualities of Wagner’s operas. These two had both been diagnosed with autism rather than AS (the remaining participant with autism was a skilled performer on the piano, and belonged to the classical group).

Why participants engaged with music: motivations

The full tree diagram for the motivations nodes referred to in this article is included as Figure 1.

Our sample used music extensively to achieve a number of personal aims. The largest number (nine individuals, or 75%) was under ‘mood altering’. This node was identified early on, in our analysis of the motivations supernode. The words or phrases used to describe the moods aimed for included: ‘a buzz’, ‘exciting’, ‘ethos and excitement’, ‘exhilaration’, ‘feeling better about things’, ‘chillout’, ‘calmness or serenity’, ‘makes me feel at peace’, ‘relaxing’, ‘calming’.

The majority of this set of words can be grouped into two clusters. ‘A buzz’, ‘exciting’, ‘ethos and excitement’ etc. are synonyms or near-synonyms for a state indicating pleasurable arousal. ‘Chillout’, ‘relaxing’ etc. are synonyms or near-synonyms for states of pleasurable lack of arousal. Under the tree node for ‘mood altering’, we created a subnode comprising statements about changes in arousal, with two nodes under it (‘arousal’ and ‘relaxation’) to accommodate the two clusters.

To accommodate the three examples which did not fit clearly into these categories (‘cheer up’, ‘feeling better about things’, ‘sometimes made me happy’), we created a separate subnode of ‘mood altering’, a subnode we denoted ‘valency change’. This subnode was coded into two further subnodes to signify both the (occasional) use of music to achieve an explicit state of happiness, and statements by a different set of individuals that they did not use music in that way. This is illustrated in the model included at Figure 1.

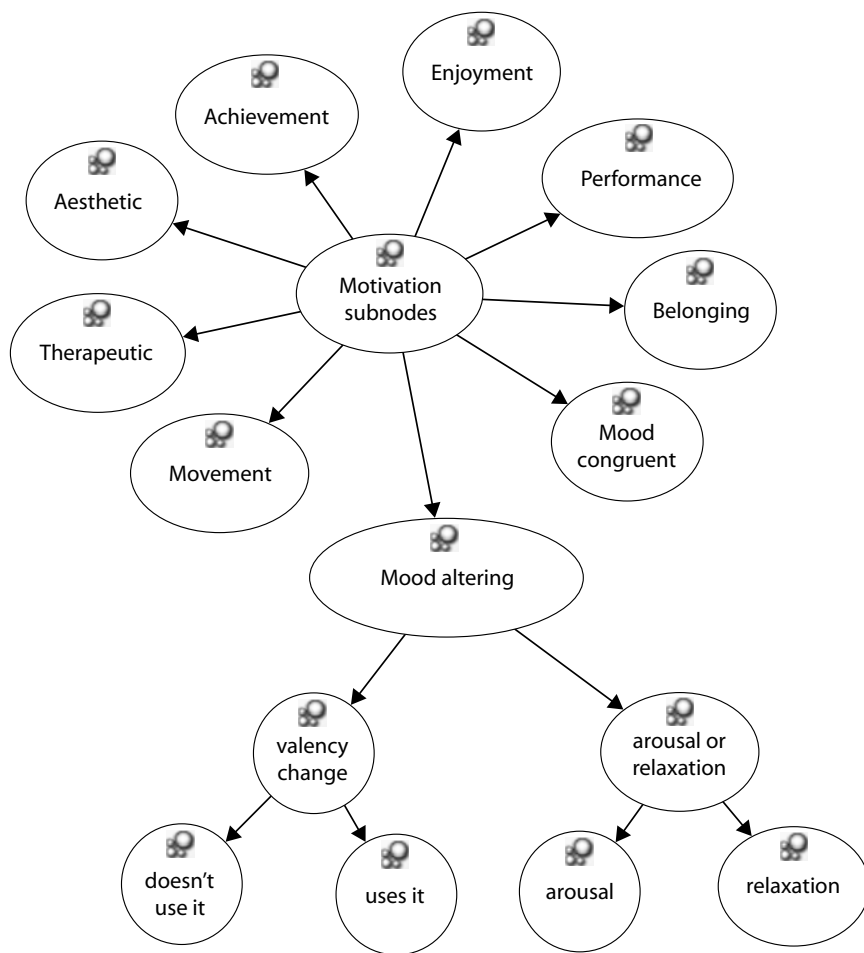


Figure 1 'Motivations' subnodes

Though it is not reflected explicitly in the coding, the motivation for achieving a more relaxed frame of mind was in several cases stated as the need to counter anxiety or tension: 'if you feel tense and you want something to calm you down'; 'so that I don't get over-anxious and over-heated up'; 'when I've felt disappointed [i.e. frustrated]'; 'music is calming if I'm anxious, it distracts me from unpleasant thoughts in my head'.

However, one person explicitly denied using music to change his mood in any way. Two out of the three instances of the use of music for valency change (i.e. to achieve change of mood along the sad/happy axis) were qualified by the participants, for example: 'When I started getting more severe medical problems a few years ago, then I was playing happier music

to cheer myself up. Not exactly cheer me up, but keep me on a level.' And five participants explicitly denied using music to induce valency changes.

After 'mood altering', the next most numerous category was 'aesthetic appreciation', with seven (58%) individuals mentioning this. The 'aesthetic' category refers, by the definition we adopted for the purposes of this study, to feelings of pleasure that are derived from the conscious or intellectual perception of certain qualities of the music, rather than being a spontaneous emotional reaction to it. 'Aesthetic pleasure' thus refers to a reaction in the listener; it is important to retain the distinction between this and, for example, 'structure', the latter being a characteristic of the music that might provoke a reaction of aesthetic pleasure, rather than that reaction itself. In the aesthetic category we included participants' descriptions of the pleasure they derived from the lyrics, the 'ethos', the pattern, the structural complexity, or simply the 'sheer beauty' of the music.

The next commonest category was 'therapeutic'. Six participants (50%) reported experiences in which listening to music had had a healing effect.

'Therapeutic' and 'mood altering' categories both referred to changes of internal states. Confusion between the two categories was avoided by using 'mood altering' to describe a cluster of statements comprising a limited range of words synonymous with either excitement/exhilaration or calmness/relaxation, and containing no explicit statement suggesting a healing or therapeutic effect. A different cluster of statements described the use of music to heal emotional pain or depression, and these were denoted as 'therapeutic', for example: 'When I have been feeling depressed, I have listened to certain music, and I would claim the music healed me', and 'Nothing worked for me – therapy didn't work – but listening to this chap [singer Carl McCoy] actually worked.'

The next most popular headings, with five participants each, were 'belonging' and 'performance'. These tended to co-occur, with four participants reporting in both categories. In the 'belonging' category, characteristic quotes were as follows:

When someone's released a classic album and you listen to it, I think 'I'm part of something great now.'

I hear a lot of music in church, I go on Sunday and Monday and Thursday as a rule . . . you can relate to it, sometimes if you're not at that church, if the same song comes along sung by a different congregation, you can relate, it makes you feel a part of something.

There's something about pop music, it's the image, and to do with people of my generation, rather than adults inflicting it on you.

Two quotes illustrating different aspects of the 'performance' node were as follows:

[as a child] I used to go into a nearby wood and sing at the top of my voice, which was exhilarating.

I'm a lot of the time a restless character, and I got a bit carried away with Queen, because I wanted to perform, to perform on stage and have people adoring me, I just wanted attention, I wanted people to say 'oh look at me', I'm a showman.

'Mood congruent', 'movement' and 'enjoyment' were chosen by four participants each.

'Achievement', with three individuals, included the two highly competent classical musicians in the sample and referred to their delight in mastering a difficult piece or, for one individual, a difficult musical mode (e.g. Dorian, Phrygian).

The distribution of these nodes among the classical and pop subgroups (omitting the 'neither' subgroup) are shown in Figure 2.

What music they engaged with: characteristics

The node structure for this tree is given in Figure 3. Under the 'characteristics' node, we created a subnode that included the features of music associated with its energizing or calming effect. Ten out of 12 participants described characteristics linked to this aspect, with participants enjoying rousing music; their descriptions included 'go-ey', 'loud and lively', 'fast', 'exciting', and they suggested it had 'raw energy', 'power', 'impulse' or 'a lot of beat and rhythm'.

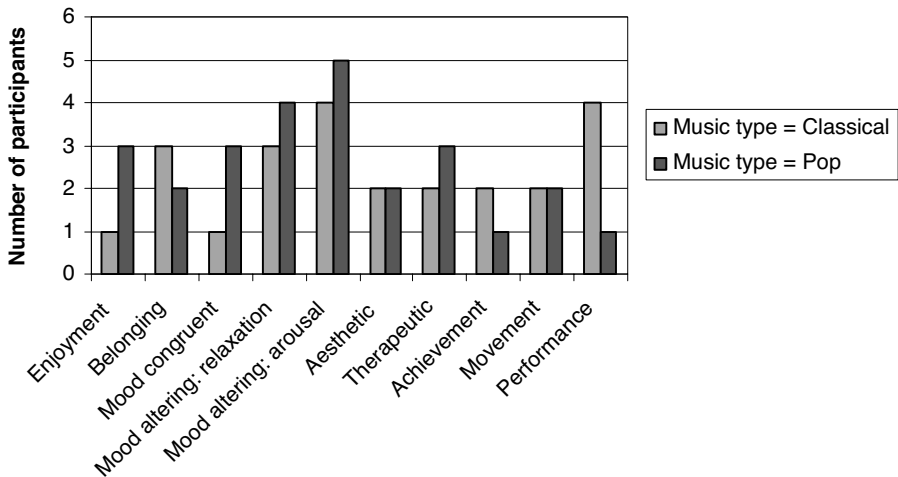


Figure 2 Numbers of participants in 'classical' and 'pop' groups, by motivations subcategory

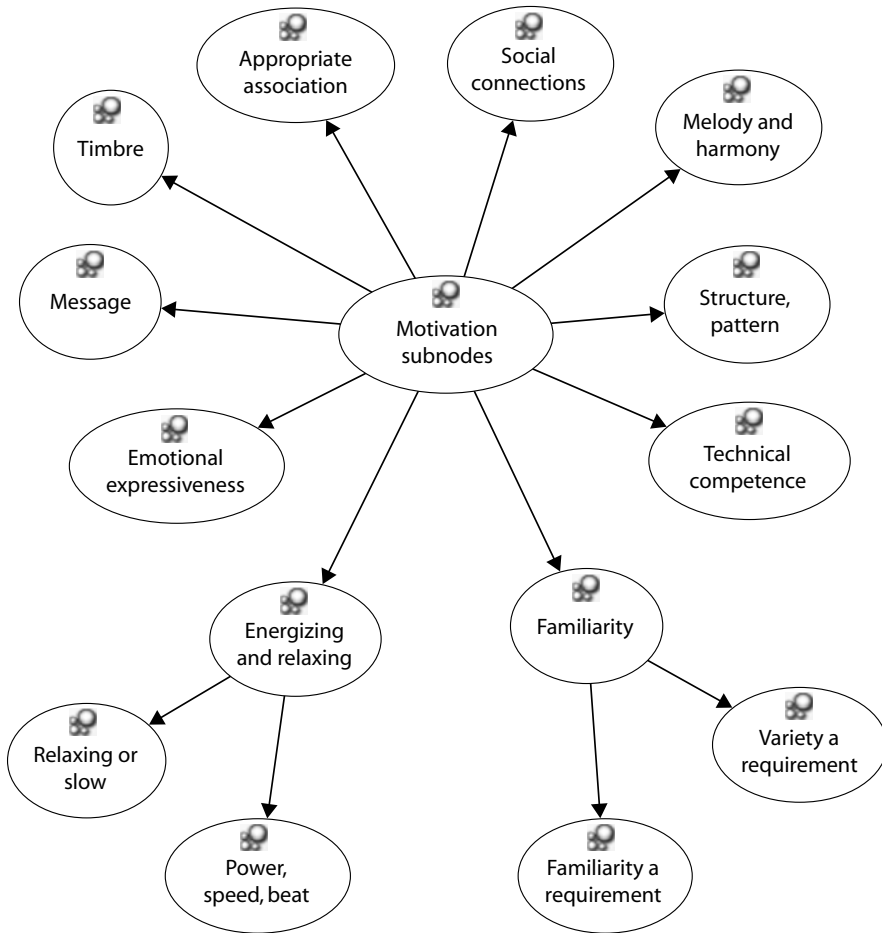


Figure 3 'Characteristics' subnodes

Five of these participants sometimes enjoyed slow quiet music to induce an effect of relaxation, when appropriate. However, several participants categorically disliked slow music, describing it as 'dirgey', 'boring' or 'dragging on'.

Eight participants (67%) mentioned structure or pattern as one of the characteristics of the music they liked. Not all of these gave rise to entries in the 'aesthetic' category of musical motivations mentioned above, because in some cases an appreciation of structural aspects was not the key reason for listening to it and therefore did not count as a 'motivational' factor.

'Appropriate associations' were also important, being mentioned by eight people (67%). This category included cases where the significant

factor was that the music was appropriate to the context, or because certain music induced pleasant thoughts. For one individual, music was only important in the context of film music, but seven others (58%), for whom music had a wider significance, also mentioned that film music was helpful in establishing atmosphere.

Emotional terms or associations, for example, ‘faster and happier’, ‘happy and forthright’, ‘plaintive’, ‘sad songs’, ‘slushy harmonies that instantly appeal’, and ‘cheerful or darker’, were mentioned by eight (67%) participants.

The importance of melody and harmony was mentioned by four participants, but melody was never mentioned on its own.

Dislike of change was mentioned by four participants, whilst for another four, variety was sometimes desirable (four made no mention of this aspect).

Social connections were mentioned by four participants, in the context of introducing them to music, for example: ‘I went to Australia when I was 20, and my friend in a record shop saved me a box of singles, when I heard some new groups’, and ‘Me and my mates Tony and Simon, we are very much into Phil Spector.’

The between-group (classical and pop) distribution of these characteristics is shown in Figure 4.

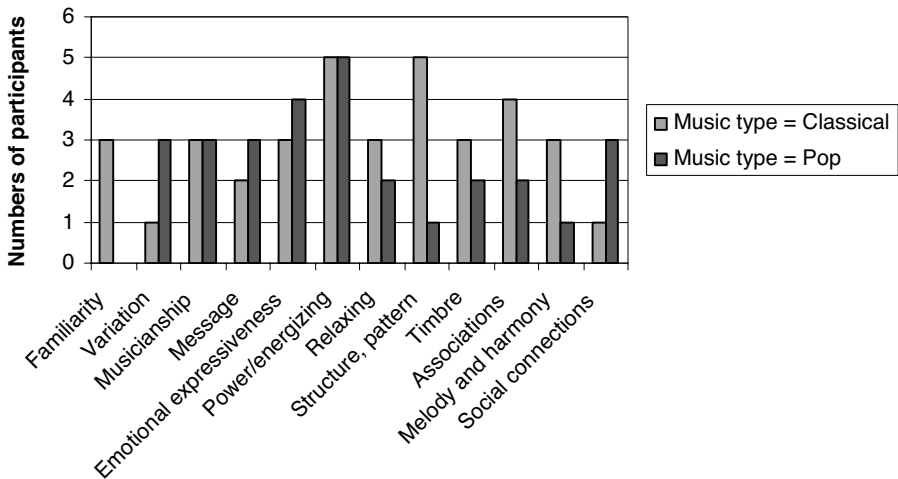


Figure 4 Numbers of participants in ‘classical’ and ‘pop’ groups, by characteristic subcategory

Discussion

Previous studies into music and autism have been limited to testing identifications between musical components and conventionally associated moods, and have provided no insights into the musical experiences of individuals with ASD or how these might differ from the TD population. In contrast, a growing body of research has studied how and why TD individuals listen to music, noting for example the importance of mood management, personal development and social affiliation (Batt-Rawden and DeNora, 2005; DeNora, 2002; Lamont, 2006; North et al., 2004). Whilst we can make no direct comparison between ASD and TD samples, the TD work provides a context in which we can consider music in autism.

In contrast to previous experimental studies that provided total numbers of affective response categories, the present study adopted a methodology that was open-ended, as this was deemed to be the most effective way of eliciting information about personal experiences.

Motivations: mood change

The fact that five participants explicitly denied using music to induce valency changes is consistent with statements by eight (67%) of the participants that they had difficulties in verbalizing their own emotional states or understanding those of others, for example: 'I find it difficult to talk about basic emotions because I don't think in terms of those emotions', or 'I don't know a lot about emotions, or know whether that was the emotion I was intended to feel [when watching a film]', or 'Emotion is a vague area for me. I really can't quantify it, and I find it impossible to say what an emotion is. I can understand the basics, a smile or a tear, and apart from that it's too complicated for me.'

This finding is in line with studies by Berthoz and Hill (2005) and Hill et al. (2004a) (but see also Fitzgerald and Bellgrove, 2006; Hill and Berthoz, 2006), who found that their sample of adults with high-functioning forms of ASD were able to report on their emotional processes, but that they had significantly higher scores than the matched control group on standardized tests of alexithymia. The authors interpreted this as showing that their ASD sample experienced emotional arousal and were conscious of such arousal, but had difficulties, relative to controls, in verbalizing their emotional experiences and in analysing their own emotional states and reactions.

Our sample did indeed show a normal to high degree of conscious awareness of the emotional arousal induced by music, though they were generally limited to describing the effect in terms of excitement on some occasions or calmness and relief from tension on others, suggesting that they had precisely the difficulties in verbalizing and analysing emotional

experiences and poor insight into these experiences reported by Hill et al. (2004a) and Berthoz and Hill (2005). This reinforces the need to draw a distinction in ASD between the experience of emotions and the ability to analyse and to report on them, especially where emotional reactions to music are concerned.

The most interesting finding among the motivations subnodes arose from the analysis of the largest subnode of the 'motivations' category, involving the use of music to achieve changes in mood.

This showed descriptions of desired states clustering around the two regions of exhilaration and calmness. Four participants described the state of tension as undesirable, but one which could be relieved by the calming effects of music. Participants were not explicitly asked whether they sought calmness as a relief from tension, but the fact that four nevertheless spontaneously mentioned the need to reduce tension when speaking about the need for relaxation implies the existence of a mood axis or dimension, ranging from calmness to tension, among our participants. The arousing or exciting effect of music was not clearly identified as having an opposite pole, though one person did describe feeling 'emotionally dead a lot of the time'.

Therapeutic

The size of this category (six individuals) shows that music does indeed have a healing value for some adults with ASD. A study by Batt-Rawden and DeNora (2005) claimed that a number of TD individuals suffering from chronic illness had also gained therapeutic benefits from music.

Belonging

The fact that five out of 12 (42%) of our sample found benefits from this aspect of music shows that, for our sample at least, music fulfilled a role in reducing the loneliness commonly associated with ASD.

The first two of the quotations cited in the results section illustrate the feeling that association with a musical experience made the listener feel 'part of something'. The third quotation added the interesting detail that the individual concerned was aware of belonging to a generation for which certain types of music helped to define their identity. Such feelings are a commonplace of musical experience in the wider population, but it is perhaps surprising to see them expressed so unambiguously within this group.

It might be expected that there would be an overlap between the 'belonging' set in the motivations category and the 'social connections' group within the characteristics category, but only one individual was in both sets. It may be that the need to feel 'part of something' is less for those with friends with whom they can enjoy and discuss music directly.

Performance

Three out of the five individuals in this category played music in some public setting (e.g. in church), and enjoyed the act of making music rather than the fact that it was a public event. The first of the two quotations in the results section, from a person who incidentally described herself to us as being completely unmusical, illustrates that pleasure in making music could be quite independent of reciprocal public involvement. The second quotation, by contrast, shows the dominant role of audience involvement in the strong desire of one individual to perform publicly.

Characteristics

The salience of ‘power’ as a desirable characteristic of music is consistent with the principal use made of music, to change mood, of which inducing a feeling of excitement or exhilaration is prominent. Powerful music seems likely to be an effective stimulant of such states. The dynamics of the music appear to be important in providing ‘power’: speed, beat and rhythm were specifically mentioned here. The importance of ‘structure’ is consistent with the salience of the ‘aesthetic’ use of music, though this admittedly is partly a consequence of the assumptions we made in defining the ‘aesthetic’ category, namely that enjoyment of structure in music counts as an aesthetic reaction to it. The size of the ‘social’ category shows that this aspect cannot be ignored in considering music and autism. The importance of ‘timbre’ was unexpected, but is consistent with reports of enhanced perception in autism (Mottron et al., 2006) and merits further investigation.

It may be of interest that emotional terms or associations were used in describing music by eight participants, despite their claiming, elsewhere in the interviews, that they didn’t understand these terms when they concerned relations with other people.

Whilst the importance of melody and harmony was mentioned by four participants, melody was never mentioned on its own, suggesting that this musical component has a low profile in the musical vocabulary of this group of participants.

Given that dislike of change is often characteristic of autism, it might be expected that familiarity might be a requirement for favourite musical items, but it was mentioned by only four participants in our study.

Profile differences between pop and classical groups

The differences in the profiles of the ‘pop’ and ‘classical’ groups for the overall category of motivations suggest that, as might be predicted, the more formal and perhaps musically deeper engagement of the classical group is reflected in an emphasis on the enjoyment of performance and the more intellectual/aesthetic side of music, whilst the pop group benefits

somewhat more from the purely emotional charge of the music, with higher numbers represented in 'enjoyment', 'mood congruent', 'mood altering' and 'therapeutic'. The greater emphasis on musical qualities such as structure, melody and timbre in the 'classical' compared with the 'pop' group might have been expected, given the higher overall level of formal musical training of the classical cohort. The greater importance of 'social connections' for the 'pop' group, referring to the fact that friends had introduced them to new types of music, might reflect the more fan-based nature of this musical category. The importance of familiarity in the 'classical' group, and of variety in the 'pop' group, was unforeseen, but might be explicable on the basis that individuals whose musical tastes formed relatively late in development may have been more prepared to take risks with their musical choices as compared with those whose listening patterns were formed as children. Alternatively, it may reflect differences in levels of complexity or other variables in the music itself.

Reliability, validity and objectivity

These constructs are of limited applicability to qualitative research, though Spencer et al. (2003), especially on pp. 59–69, discuss ways in which they can be defined in qualitative studies. However, to those familiar with quantitative research, for whom reliability etc. have specific technical definitions, it might be more informative to discuss the issues in terms such as dependability, credibility and confirmability.

The issues of dependability and credibility are analogous to the terms 'reliability' and 'validity' in Spencer et al. (2003). This includes the extent to which the means of data collection, and the interaction between researcher and participant, is liable to have affected the data. It is arguable that the precise formulation of our semi-structured questionnaire was not critical to the outcome. Pidgeon and Henwood specifically warn against 'becoming constrained by pre-formulated questions rather than adopting a more open-ended conversational style' (1997, p. 258), and Spencer et al. include 'listening rather than talking' (2003, p. 59) as a prime consideration in what they term 'validity'. In the present study, the supplementary questions were available as prompts if the conversation flagged, but in most cases we found that the rather formal process of completing the early experience questionnaire broke the ice, and led on naturally to the discussion of how the participant's musical interests had evolved since childhood or adolescence. This approach, via the participant's personal history, turned out to be highly productive. In many cases, participants would talk for 10 or 20 minutes or even longer on their personal musical histories, making it unnecessary to do more than add the occasional prompt to explore further aspects of their experiences and restore the flow of the participant's conver-

sation. The contamination of the results by the experimenter's preconceived ideas, which might be seen as a major threat to credibility in exploratory qualitative studies, was thus kept to a minimum.

The fact that our autism group was a convenience sample limits the extent to which our results can be generalized to the total population of high-functioning adults with ASD, though as Accordino et al. (2007) comment with regard to analyses of music therapy: 'while the research on more than one client may lack the detail of a case study, it is much more generalizable than a case report that only notes changes in a single participant'. Nevertheless, confirmability is one area of limitation in our study. We engaged in a degree of member checking during the interviews, in the sense of summarizing or restating assertions to ensure that we had not misunderstood participants. However, given that our main findings were obtained after the conclusion of the interviews, we had no opportunity to check these systematically with participants and thus no ability to triangulate our results.

TD populations: similarities and differences

Our results showed that music was used by our sample in several ways that were similar to those reported in TD literature, such as mood change, self-management for depression, and social affiliation. However, we found one striking difference. TD individuals describe their mood changes in response to music as lying along two axes, one single axis of valency (happy/sad), and another single axis of 'arousal' (Bigand et al., 2005). But our sample showed almost no use of valency terms, and instead used descriptors of states lying along two dimensions of arousal, with calmness/tension as opposite poles of one axis, and excitement or exhilaration as the desired state on the other axis.

This suggests similarities with a model described by Thayer (1978), which, however, expands the traditional concept of arousal from one to two dimensions rather than describing mood space. He identified dimensions of vigour/tiredness and of tension/placidity. The latter clearly maps onto the tension/calmness dimension of our participants. The vigour/tiredness axis was not observed in its entirety here, though it is plausible that the node characterized by descriptors such as 'excitement' and 'exhilaration' is identical with the 'vigour' pole of Thayer's vigour/tiredness axis.

The fact that our ASD group consistently used terms which described internal states of arousal (calm, tense, exhilarated etc.) to describe the subjective impact of music, rather than terms implying valence (happy, sad etc.), is consistent with findings by Capps et al. (1992) and Bormann-Kischkel et al. (1995) that the facial emotions for which their autism group showed specific recognition impairments were those (such as embarrassment or

surprise) with an external locus of control and which required knowledge of social scripts, rather than those which were mere signs of inner states. It is also consistent with the comment in Bowler that 'individuals with ASD seem to engage in less top-down processing when making perceptual judgements, that is to say, their reactions to the world are based on information that is closer to the properties of the incoming stimulus' (2007, p. 246). Attributing emotional characteristics to music would seem to involve more top-down processing than describing changes in internal arousal.

However, the absence of a comparison group in this study limits the degree to which findings in this sample can be compared to typically developing populations. Our findings must therefore remain somewhat tentative until they are replicated with a larger sample and a comparison group. It would also be of interest if a study of childhood descriptions of musical experience were carried out to enable a comparison between typically developing and ASD individuals at an earlier developmental stage.

Conclusions

We have shown that individuals with ASD can respond profoundly to music, and show considerable understanding both of the music and its effects on them. Whilst our group generally found it difficult to verbalize their emotional responses to music, other than in terms of internal arousal states, they clearly experienced a wide range of benefits from it. Our sample, which was not selected for musical experience, exposure or knowledge, actively and consciously used music in their daily lives.

The two outliers in the subgroup whose engagement with music was limited seem to have levels of musical understanding which are in this respect relatively restricted: they may be characteristic of a subtype of which Temple Grandin, who reports 'not getting' music (Sacks, 1996), is an example. Without extending our study to a larger and more representative sample, it is impossible to say with certainty how large a proportion of the high-functioning ASD population may fail to engage with music, but we would suggest that it is likely to be a minority.

The majority of our group found music of value in achieving improvements in mood, as well as for improving personal and social integration. This suggests that there are likely to be extensive practical benefits if caregivers or clinicians working with high-functioning adults with ASD encourage them to foster their musical interests.

Appendix I: semi-structured questionnaire

Autobiographical memories about reactions to music

- Can you remember when you first began to get interested in music?
- How old were you then?
- What do you remember liking about it?
- Can you think back to when you were really young, and you began to listen to music and to people talking? Did you prefer one to the other?
- Do you think you might have liked music at this time? If you did, what did you like about it? Did it seem to make sense to you? If so, why?
- How did your liking for music [if any] develop over time as you got older?

Current reactions to music

- What is it about music that makes you want to listen to it now – what does it do for you?
- Do you see images when you listen to music: landscapes, shapes, people, colours?
- How important to you are the lyrics in songs, as opposed to the music?
- Does music make you feel emotional? For example, happy or sad or frightened or angry or anything like that?
- What do you think it is about the music that makes you feel like that? (If respondents have outlined three different emotions, go through them separately.)
- Do you find different kinds of music, for instance classical music or jazz or pop music, makes you feel these things more than another?
- What do you think it is about jazz (classical etc.) that makes you feel like that?
- If you watch a movie that is supposed to be scary, would it be less scary if you watched it without the music?
- What about if it was supposed to be happy: would it seem less happy without the music?
- Does the music ever help you understand what is going on when you watch films or TV?
- If you were feeling really happy one day and you heard some sad music, would it change your mood? And what about if you were feeling sad and then heard happy music?
- Do you have any particular piece of music that you associate with something happy that happened in the past? Or maybe something sad or exciting that happened in the past?
- Do you have any particular piece of music that reminds you of a particular person? If yes, why?

Appendix 2: early musical experience questionnaire

1 (a) Have you had any formal musical training (not just general music classes at school)? (Please indicate below the extent of this)

(none) 1 2 3 4 5 6 7 (professional)

(b) If yes, for how many years? (Please circle)

0 1 2 3 4 5 6 7 8

2 As a child, did you engage in any of the following musical activities for at least a year? If so for how long per week? (Please circle)

(a) Individual music lesson ½ h 1 h 1½ h 2+ h

(b) Class music lessons ½ h 1 h 1½ h 2+ h

(c) Music therapy ½ h 1 h 1½ h 2+ h

(d) Dance/movement classes ½ h 1 h 1½ h 2+ h

3 How often did you, as a child, choose to listen to music at home? (Please circle)

Rarely Moderately Frequently: once per week
2-4 times per week every day

4 How would you rate your reaction to music then? For example, music played on the radio. (Please circle)

Dislike Indifference Mild liking
Moderately enthusiastic Very enthusiastic

5 Did you quickly memorize new tunes you heard? (Please tick)

Yes No

6 Did you sing back other kinds of sounds that you heard around you? For example, car horns, elevator bells, door bells etc. (Please tick)

Yes No

If so please give examples below:

.....

7 Did you sing songs/melodies to yourself or other people? (Please tick)

Yes No

If so how often?

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