The Acquisition of Pitch Identification Abilities in Autism Spectrum Conditions

Ben Handysides
Niko Kargas

School of Psychology
UROS
University of Lincoln

Background

Approximately 10% of people with Autism Spectrum Conditions (ASC) possess savant skills, largely occurring in the areas of calendar calculation, arithmetic, art and music (Rimland, 1978).

Absolute Pitch (AP):
The ability to identify or reproduce musical notes without an external reference (Baggaley, 1974).

Little is known as to how AP is acquired, though some theories include:

- Tonal languages:
  - AP is more common in Mandarin speaking musicians (Deutsch, Henthorn, Marvin & Xu, 2006)
    - Infants process pitch absolutely, whereas adults use relative processing (Saffran & Griepentrog, 2001)
  - In tonal languages, this shift to relative processing may not occur.
- Early Musical Exposure:
  - Exposure to musical training in the critical language period may lead to the brain processing musical pitch as if a component of language (Bossomaier & Snyder, 2004).
  - Some absolute processing of pitch is preserved in most people, but without verbal labels for pitches, this results in absolute *memory* for pitch only.

Musically untrained children with ASC are able to associate musical notes with novel retrieval labels, suggesting different routes to AP in autism than typical development (Heaton, Hermelin & Pring, 1998).

In musicians with AP, autistic traits are more common and are positively correlated with pitch identification ability, but not overall musical ability (Dohn, Garza-Villarreal, Heaton & Vuust, 2012).

Research into the relationship between autism and pitch identification/discrimination ability has shown both enhanced and diminished performance, with evidence of distinct subgroups (Heaton et al., 2008; Kargas, López, Reddy & Morris, 2014).

Atypical sensory behaviours are common in autism, however little research has considered auditory sensory profile in predicting pitch identification ability.

Figure 1. Block Design cubes (WAIS-IV)

Aims

To determine whether the apparent predisposition towards the acquisition of Absolute Pitch in ASC extends into adulthood.

To test whether the apparent predisposition towards the acquisition of AP is found in the Broader Autism Phenotype (BAP).

To identify relationships between auditory sensory behaviours and pitch identification abilities in ASC and typical development.

Methods

Participants:
35 adults aged 18-24 with normal intelligence and normal hearing were organised into two groups: a clinical group of 5 males and 1 female with ASC and a control group of 6 males and 23 females.

Materials:
AQ-10 - 10 item questionnaire designed to measure autistic traits in typically developing adolescents/adults

Adolescent/Adult Sensory Profile - Measures sensory behaviours across 4 subscales (Sensation seeking, sensory avoidance, sensory sensitivity and low registration). Only the items for auditory sensory sensitivity and low registration were used.

WAIS-IV - An IQ test which provides scores for performance and verbal IQ, as well as working memory.

Pitch Identification Tasks - Computer-based tasks in which participants identify musical notes using colour-coded response keys. 3 tasks were made: a pre-test (PIT-1), a training task (PIT-T) and a post-test (PIT-2).

Figure 2. Colour-coded response keys for pitch identification tasks

Procedure:
Participants first completed the questionnaire measures, followed by PIT-1 and PIT-T, the WAIS was then administered, followed by the PIT-2 (approx. 30 mins after the PIT-T).

Results

Autistic Traits and Auditory Sensory Behaviours:
Autistic traits are positively correlated with auditory low registration behaviours, but not with auditory sensory sensitivity. The ASC group reported significantly more auditory sensory behaviours than the control group.

Factors affecting Accuracy of Pitch Identification:
Pitch identification scores are similar across groups for the PIT-1, and higher in the ASC group for the PIT-2. There was a significant level of improvement in PIT scores in the ASC group, but not the control group *(Figure 3)*.

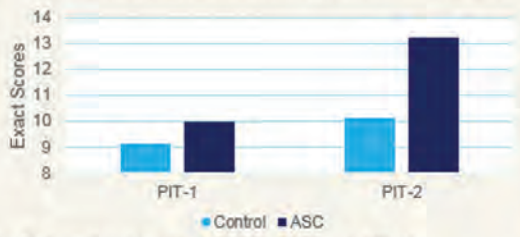

Figure 3. Group mean scores on the PIT-1 and PIT-2

One participant in the ASC group performed at ceiling on both the PIT-1 and PIT-2, indicating AP. They were not musically trained and did not differ significantly on any other measures to the ASC group means.

AQ subscales show opposite relationships with the PITs between groups:
In the control group, PIT-2 scores are marginally significantly negatively correlated with communication and social skills, though these effects are diminished when controlling for auditory low registration.
In the ASC group, PIT-2 scores are positively related to AQ, and this is driven by the Communication factor, an effect which becomes stronger when controlling for low registration.

Auditory low registration is negatively correlated with PIT-1 and PIT-2 performance in the control group only, however there is no relationship between PIT-2 and low registration after controlling for baseline performance.

Discussion

As predicted, auditory low registrations show a positive relationship with autistic traits. The same pattern is not found for sensory sensitivities however.

Autistic traits, particularly the communication subscale, appear to have opposing effects on PIT performance between groups. In the control sample, this relationship is negative and mediated largely by auditory low registration, however the reverse relationship is observed in the ASC sample and does not seem to be influenced by auditory sensory behaviours.

While the mean scores on the PIT-2 were not significantly higher in the ASC group, the degree of improvement from the pre-test to the post-test was; perhaps indicating that there is in fact a predisposition towards the acquisition of enhanced pitch identification ability in ASC.

Previous research has produced inconsistent results on the relationship between autism and auditory perceptual tasks such as pitch identification.
The results here suggest that this may be partially accounted for by auditory sensory behaviours, which appear to have different effects between groups. Additionally, this may reflect a categorical difference between groups, rather than a continuous effect dependent on autistic traits. Thus, a predisposition towards AP may not be observable in the Broader Autism Phenotype.

The present study is ongoing and aims to achieve a larger sample, however the preliminary analysis is in support of previous research in the sense that pitch identification ability is more responsive to training in ASC than in typical development, suggesting a possible predisposition towards the development of AP.

The findings here also differ from previous research however, in that these findings are generally only observed in children. Further research therefore should replicate the procedure within a sample of children and adolescents with and without ASC.

Conclusions

Preliminary evidence was found of a predisposition towards the development of enhanced pitch identification ability in adults with ASC, but not typical development, and this appears to be positively related to the number of autistic traits in clinical populations.

Evidence was also found of a subgroup of individuals with ASC who possess enhanced pitch identification abilities analogous to AP, in the absence of formal musical training.
The present study also highlights the importance of considering the role of sensory atypicalities in future research.

Key References

Bossomaier, T., & Snyder, A. (2004). Absolute pitch accessible to everyone by turning off part of the brain? *Organised Sound*, *9*(2), 181-189. https://doi.org/10.1017/s1355771804000263

Dohn, A., Garza-Villarreal, E. A., Heaton, P., & Vuust, P. (2012). Do musicians with perfect pitch have more autism traits than musicians without perfect pitch? An empirical study. *PLoS ONE*, *7*(5), e37961. https://doi.org/10.1371/journal.pone.0037961

Heaton, P., Hermelin, B., & Pring, L. (1998). Autism and pitch processing: a precursor for savant musical ability? *Music Perception: An Interdisciplinary Journal*, *15*(3), 291-305. https://doi.org/10.2307/40285769

Heaton, P., Williams, K., Cummins, O., & Happé, F. (2008). Autism and pitch processing splinter skills: A group and subgroup analysis. *Autism*, *12*(2), 203-219. https://doi.org/10.1177/1362361307085270