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The Audio-Visual Abnormalities Questionnaire (AVAQ): Development and validation of a new instrument for assessing abnormalities in sensory perception in schizophrenia spectrum disorders

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Abstract

Background: Anomalies in visual and auditory perception represent an important aspect of the symptomatic manifestation of schizophrenia (ScZ). However, there are currently no instruments available that allow the assessment of the full range of auditory and visual abnormalities using a self-report measure.

Methods: We developed the 85-item Audio-Visual Abnormalities Questionnaire in Schizophrenia (AVAQ) to assess abnormalities in auditory and visual processing. The AVAQ was validated in an online-sample of 355 healthy participants to establish the factorial structure, internal consistency and reliability of the instrument. In addition, participants completed the Autism-Spectrum Quotient (AQ) and the Schizotypal Personality Questionnaire (SPQ) to establish convergent validity regarding autistic and schizotypal traits.

Results: High internal consistency was observed for the total AVAQ-scale (α = 0.99) as well as for the visual (α = 0.98), auditory (α = 0.96) and the audio-visual subscales (α = 0.83). Principal component analyses demonstrated one factor comprising of 78 items. The AVAQ was positively correlated with the SPQ ($r = 0.69$, $p < .001$) as well as the AQ ($r = .38$, $p < .001$). Correlations with the SPQ were highest for unusual perceptual experiences ($r = .72$, $p < .001$) and lowest for social anxiety ($r = 0.30$, $p < .001$).

Conclusion: The AVAQ demonstrated excellent reliability, internal consistency and construct validity. Accordingly, the instrument could be useful for characterizing sensory dysfunctions across the schizophrenia spectrum that could guide interventions as well as aid the development of biomarkers.

Introduction

Schizophrenia (ScZ) is a severe mental disorder characterized by disruptions in thought, perception, emotion and behaviour with a typical onset during adolescence and early adulthood. A core aspect of the clinical presentation of the disorder is the presence of pronounced impairments in cognitive functions that precede the onset of psychosis and largely remain unchanged following treatment (Kahn and Keefe, 2013). Importantly, cognitive impairments are related to functional outcome and current psychosocial functioning (Green, 1996), highlighting the importance of characterizing the extent and mechanisms of cognitive dysfunctions in ScZ.

Traditionally, research into cognitive deficits has focused on impairments in higher cognitive processes, such as executive functions, working memory (WM) and attention, while impairments in early sensory processes were largely considered unimportant (Uhlhaas and Mishara, 2007, Javitt, 2009). More recently, there is emerging evidence that deficits in visual and auditory processes constitute a fundamental aspect of the pathophysiology of ScZ (Javitt and Freedman, 2015, Butler et al., 2008), and this is supported by several streams of research. Firstly, phenomenological evidence has consistently highlighted that changes in self-experiences often involve aberrant sensory perception in the prodromal and early stages of ScZ (Matussek, 1952, McGhie and Chapman, 1961) that can predict the onset of ScZ in at-risk individuals (Klosterkotter et al., 2001). Secondly, psychophysical data from both visual and auditory domains highlight basic disruptions in the registration and integration of sensory information (Javitt, 2009, Uhlhaas and Silverstein, 2005, Butler et al., 2008, Keri et al., 2005). This is furthermore supported by a wealth of evidence from electro- and magnetoencephalographical (EEG/MEG) studies that have identified pronounced deficits in pre-attentive indexes of sensory processing, such as the P50, Mismatch Negativity and steady-state responses (Thune et al., 2016, Erickson et al., 2016, Bramon et al., 2004, Javitt et al., 2008). Data also indicate abnormal function as early as the retina in ScZ and in children at risk (Silverstein and Rosen, 2015, Demmin et al., 2018, Hebert et al., 2010).

Finally, this data is complemented by anatomical and neurobiological findings indicating that: 1) circuit impairments, including dysfunctions in interneurons, alterations in synaptic density and reduction in cortical thickness, that have been traditionally associated with the brain areas supporting higher cognitive processes, such as the prefrontal cortex, extend into primary auditory and visual cortices (Selemon et al., 1995, Hashimoto et al., 2008, Reavis et al., 2017); and 2) retinal thinning and other structural retinal anomalies have consistently been observed in schizophrenia (Yilmaz et al., 2016, Silverstein et al., 2018), highlighting the importance of early sensory stages for the understanding of the neurobiology of ScZ.

While the relevance of sensory dysfunctions for understanding the pathophysiology of ScZ has been increasingly recognized (Silverstein, 2016, Javitt and Freedman, 2015), few instruments are available that comprehensively characterize disruptions in auditory and visual processing. Changes in sensory perception are not part of standard assessments of psychopathology, such as the Positive and Negative Syndrome Scale (Kay et al., 1987) or Scale for the Assessment of Positive and Negative Symptoms (Andreasen, 1981). Similarly, changes in sensory processing are not incorporated into interviews or self-report scales of cognitive functioning for use in ScZ (Keefe et al., 2006, Welch et al., 2017).

Semi-structured interviews, such as the Bonn Scale for Assessment of Basic Symptoms (BSABS) (Gross, 1987) have several items examining auditory and visual alterations that have been found to be associated with deficits in psychophysical performance (Keane et al., 2018, Keri et al., 2005). The Structured Interview for Assessing Perceptual Anomalies (SIAPA) (Bunney et al., 1999) has been specifically developed to assess aberrant sensory experiences in ScZ. A limitation, however, of semi-structured interviews is the time-required to administer these measures which limits the use of such instruments for population-wide screening, for example. Finally, existing scales for the assessment of schizotypy (Chapman et al., 1978, Raine, 1991) as well as the Cardiff Anomalous Perceptions Scale (CAPS) (Bell et al., 2006) do not comprehensively assess sensory processing in the auditory and visual domains.

To address this important gap in the field, we developed the Audio-Visual Abnormalities Questionnaire in Schizophrenia (AVAQ). We focussed on alterations in visual and auditory dysfunctions as these two domains have been most consistently shown to be characterized by impairments in psychophysical and neuroimaging/electrophysiological parameters (Javitt and Freedman, 2015). Items of the AVAQ were generated through a review of existing phenomenological studies of sensory experiences in ScZ (Matussek, 1952, McGhie and Chapman, 1961) and from the extensive experimental literature on visual and auditory processing deficits in ScZ (Uhlhaas and Mishara, 2007, Silverstein, 2016, Javitt and Sweet, 2015, Javitt, 2009). In addition, we also selected items from descriptions in semi-structured interviews, such as the BASBS and SIAPA (Gross, 1987, Bunney et al., 1999).

To obtain initial data for reliability, internal consistency and construct validity, we administered the AVAQ to a group of participants (n = 355) from the general population that completed the Schizotypal Personality Questionnaire (SPQ) and the Autism Spectrum Quotient (AQ) (Baron-Cohen et al., 2001). The SPQ and AQ were administered to examine the relationships between sensory abnormalities and schizotypal and autistic traits, respectively. While autism spectrum disorders (ASDs) and schizophrenia spectrum disorders share similarities in auditory and visual processing (Dakin and Frith, 2005, Butler et al., 2008), we expected that AVAQ-scores would correlate more strongly with SPQ-scores as compared with AQ-ratings, providing initial support for the construct validity of the AVAQ for the assessment of auditory and visual processing dysfunctions in schizophrenia spectrum disorders.

Methods

Following the item-generation, 93 questions visual (61), auditory (27) and audio-visual (5) experiences, plus 5 catch questions to detect random responding, were included. The questionnaire was initially tested online in a sample of n = 112 participants from the subject pool of the Dept. of Psychology, University of Glasgow. Following this initial validation, eight items were removed either because of a) low item-total correlation b) correlation values of > .3 with any of the other items in PAQ and c) difficulties in comprehension by participants.

The revised 85 item AVAQ-scale (Appendix 1) was then tested in a sample of 355 participants that were selected through two recruitment pathways: 1) 150 participants were recruited from the subject pool of the Dept. of Psychology, University of Glasgow and 2) 205 participants were recruited using the Amazon Mechanical Turk platform (see Table 1). All participants were reimbursed for their participation through experimental credits or monetary incentives.

Participants were asked to indicate how often they experienced within the past year changes in sensory experiences on a 4-point Likert scale (3: “Nearly always” 2: “Often” 1: “Sometimes”, or 0: “Never”). The total score is summed for all items excluding the catch questions.

Enter Table 1 about here

Schizotypal Personality Questionnaire

In addition to the AVAQ, participants completed the SPQ (Raine, 1991) which consists of 74 questions which assess dimensions of schizotypal personality disorder (SPD) as defined by the DSM-III-R: eccentric behaviour, ideas of reference, odd beliefs/magical thinking, unusual perceptual experiences, strange speech, constricted affect, lack of close friends, paranoia and anxiety. The SPQ was found to have good sampling validity, high internal reliability of 0.91, test-retest reliability of 0.82 and discriminant validity of 0.63 (Raine, 1991).

Autism Spectrum Quotient

We administered the adult version of the AQ (Baron-Cohen et al., 2001) to assess correlations between autistic traits and aberrant sensory processing. The test comprises 50 statements that cover five domains associated with ASDs: social and communication skills, attention, imagination, and tolerance of change. The AQ has been demonstrated to have moderate to high internal consistency on individual constructs and a coefficient alpha for the total questionnaire between 0.64 and 0.82 (Baron-Cohen et al., 2001) (Hurst et al., 2007).

Procedure

Participants were invited through email invitations and advertisements online to complete the AVAQ, AQ and SPQ-questionnaires via a web-interface. Upon accessing the experiment, participants provided informed consent before proceeding.

Data Analysis

The data was processed using RStudio, version 3.4.3. To assess the reliability of AVAQ, Cronbach's alpha was employed. In addition, a principal component analysis (PCA) was performed to investigate the internal structure of the questionnaire. The relationships between AVAQ scores and schizotypal and autistic traits were individually tested using Pearson's *r* correlations.

Results

Participants who had answered fewer than 90% of the questions on any of the three questionnaires (AVAQ, SPQ, AQ), or endorsed 2 or more AVAQ-catch questions were removed from the analysis (n = 16 participants). In addition, four participants who scored more than 3 SD above the mean on the AVAQ were excluded.

Demographic Data and Questionnaire Data

Information regarding age and gender was not available for the MTurk sample. The percentage of native speakers as well as the history of reported mental disorders was larger compared to the University sample. In addition, the MTurk sample was characterized by higher AVAQ and SPQ-scores. Moreover, the increase in AQ-scores reached a trend level (see Table 1).

Normality tests (Shapiro-Wilk test) showed that AVAQ scores were not normally distributed ($p < 0.001$) (see Figure 1). A similar observation was made for scores on the AQ ($p = 0.002$) and the SPQ ($p < 0.001$). There were no significant gender differences for AVAQ ($t = -1.132$, $p = 0.261$) or AQ scores ($t = -1.261$, $p = 0.211$). However, male participants scored marginally higher than women on the SPQ ($t = -1.028$, $p = 0.047$). Overall, the frequency with which items on the AVAQ were endorsed was low (average score per item: = 0.67, SD = 0.2) (Supplementary Material Figure 1).

Enter Figure 1 about here

Principal Components Analysis

In order to investigate the underlying structure of the AVAQ, we performed a PCA with orthogonal Varimax rotation. The Kaiser–Meyer-Olkin (KMO) measure verified the sampling adequacy for the analysis (KMO = 0.79) which exceeded the acceptable limit of 0.5. Bartlett's test of sphericity indicated that correlations between items were sufficiently large (χ^2 (3160) = 7 849.28, $p < 0.001$) to perform a PCA.

An initial analysis was performed to obtain eigenvalues for each component in the data. Three of the components had eigenvalues over Kaiser's criterion of 1 and in combination explained 44.98% of the variance. Based on this observation and an inspection of the scree plots (Supplementary Material Figure 2), three components were retained in the final analysis. The factor loadings were visually inspected and items were retained if they showed a high factor loading (≥ .35). The majority of items yielded high loading values on both components. Overall, these results suggest that one component encompassing 78 items underlies the factorial structure of the AVAQ.

Enter Figure 2 about here

Reliability

The internal consistency of the AVAQ was tested for the overall scale as well as for the individual subsections. Cronbach's alpha yielded good to excellent results for the total scale ($\alpha = .99$), the visual ($\alpha = .98$), the auditory ($\alpha = .96$) and the audio-visual subscales ($\alpha = .83$).

Correlation of the PAQ with Autistic and Schizotypal traits

We examined correlations between the AVAQ, SPQ and the AQ (Figure 2, Table 2). The SPQ correlated significantly with the total AVAQ-score ($r = .69$) and subscales (visual: .67, auditory: $r = .68$, visual-auditory: $r = .60$). Moreover, the overall AVAQ-score showed significant correlations with all subscales of the SPQ: ideas of reference ($r = .57$, $p<.001$), social anxiety ($r = .30$, $p < .001$), magical thinking ($r =.65$, $p < .001$), unusual perceptual experiences ($r = .72$, $p < .001$), eccentric behaviour ($r = .45$, $p < .001$), lack of close friends ($r = .48$, $p < .001$), strange speech ($r = .57$, $p <.001$), constricted affect ($p = .48$, $r < .001$) paranoia ($r = .57$, $p < .001$).

There were also significant correlations between AVAQ and AQ scores ($r = .38$). However, the correlation with the AQ was found to be significantly lower than that with the SPQ (Hotelling's t-test, $p < .001$). The correlations between the visual, auditory and visual-auditory subscales of the AVAQ with the AQ were also significant ($r = .37$, $r = .39$, $r = .33$, $p < .001$).

Analysis examining the correlations between AVAQ, SPQ and AQ in the two different samples showed that the relationship between the measures were similar across the two populations, although the correlations between AQ/SPQ-ratings and AVAQ-scores were large in the Mturk sample (Supplementary Material Figure 3) (University sample: SPQ/AVAQ: $r = .55$, $p < .001$, AQ /AVAQ: $r = .34$, $p < .001$; Mturk: SPQ/AVAQ: $r = .74$, $p < .001$; AQ/AVAQ: $r = .42$, $p < .001$.)

Enter Table 2 about here

Discussion

We developed a new questionnaire to assess auditory and visual sensory abnormalities in schizophrenia spectrum disorders. Alterations in sensory processing are being increasingly recognized given the emerging evidence for profound impairments in the basic registration of sensory information (Javitt, 2009) and their relationship to impaired higher cognitive processes (Dias et al., 2011) and psychosocial functioning in ScZ (Thomas et al., 2017). Accordingly, a self-report instrument to assess visual-auditory abnormalities could be of value to assess the extent of sensory dysfunctions which in turn could potentially be relevant for guiding interventions as well as for establishing correlations with psychophysical, electrophysiological and neuroimaging measures of auditory/visual processing.

The AVAQ showed high reliability (.99) and internal consistency for the overall questionnaire as well as for its subscales. Individual item-total correlations did not fall under the value of .35. One reason for the large Cronbach's alpha is the high number of questionnaire items in the AVAQ, a scenario that has shown to improve internal reliability (Sijtsma, 2009). The internal consistency of the AVAQ was also confirmed: A PCA with 2 components showed a substantial overlap with almost all items loading on both components. Therefore, it was concluded that all 85 questions formed a single consistent and reliable measure of audio-visual processing. Similar results have been recently obtained in regards to sensory abnormalities in ASDs where sensory dysfunctions were accounted for by a single factor and the degree of sensory deficits correlated highly with AQ-scores (r = .78) (Robertson and Simmons, 2013).

Convergent validity of the AVAQ was demonstrated though significant correlations with the SPQ and its subscales. We observed large correlations between AVAQ and SPQ scores SPQ (r. = .69), suggesting that aberrant auditory and visual experiences are closely linked to schizotypy. These data are furthermore supported by correlations between AVAQ and specific SPQ-subscales, such as unusual perceptual experiences (r = .70) that exceeded correlations with other subscales, such as social anxiety (r = .29), highlighting the construct validity of the AVAQ as a measure of aberrant perceptual experiences. Importantly, these correlations were replicated across two independent online-samples, providing further support for the robust relationship between schizotypy and sensory dysfunctions.

Interestingly, correlations between the AVAQ and AQ, while significant, were substantially lower than those observed for correlations with the SPQ. Aberrant sensory experiences are an integral part of ASDs that involve alterations in the processing of configural information, contrast and motion (Dakin and Frith, 2005) similar to those observed in ScZ (Butler et al., 2008). The current data suggest that while there is an overlap between sensory dysfunctions, ASD and schizotypal traits, there may also be distinguishing aspects of sensory disturbances between the two phenotypes.

The current data thus provide further support for the relationship between auditory and visual dysfunctions and schizophrenia spectrum disorders. One question that arises from these findings is whether sensory dysfunctions reflect alterations that precede or even cause impairments in higher cognitive processes. Data from studies in clinical high-risk participants have indicated that sensory dysfunctions itself are predictive for the later emergence of psychosis (Klosterkotter et al., 2001) and impact on higher cognitive functions in established ScZ (Haenschel et al., 2007, Dias et al., 2011). Moreover, there is emerging evidence that basic visual impairments, such as in visual acuity, may predict later onset of ScZ (Hayes et al., 2018). Accordingly, future studies should systematically examine the prevalence of sensory dysfunctions across the illness course of ScZ to identify at what stages impairments in visual and auditory processing occur and their relationship to impairments in cognition as well as development of psychosis.

Secondly, we believe it will be important to establish the extent to which self-reported sensory dysfunctions as assessed by the AVAQ correlate with psychophysical impairments and neuroimaging/electrophysiological parameters. There is preliminary evidence to suggest that psychophysical impairments correlate with items of the BSABS (Keane et al., 2018, Keri et al., 2005), for example, highlighting the possibility that alterations in self-experienced sensory processing are directly linked to underlying cognitive deficits and possibly neural circuit impairments.

Finally, while the current version of the AVAQ contains 85 items that comprehensively assess distinct aspects of auditory and visual processing in schizophrenia spectrum disorders, we feel that the time that it takes to complete the questionnaire (~ 20-30 min) may be too long for large-scale studies or for routine clinical use. Accordingly, future studies need to determine whether a subset of items will be sufficient to distinguish reliably, for example, ScZ-patients from controls or from patients with other diagnoses. This would facilitate the use of the AVAQ as a screening instrument to identify at-risk populations or patient subgroups with pronounced sensory dysfunctions.

Summary

We introduce the AVAQ as a measure of auditory and visual sensory dysfunction in ScZ. The questionnaire is the first self-report measure for sensory deficits in schizophrenia spectrum disorders. Our validation data show that the measure is highly reliable with excellent internal consistency and construct validity. Specifically, we provide novel data on the close relationship between schizotypy and self-reported aberrant auditory and visual dysfunctions that highlight that sensory deficits may be at the core of schizophrenia spectrum disorders. Future studies are required to substantiate this hypothesis by the systematic investigation of auditory and visual dysfunctions during different illness stages and their relationships to the development of psychosis and cognitive impairments.

Figure Legends

Figure 1. Mean Scores per Item on the AVAQ. Participants were asked to indicate how often they experienced within the past year changes in sensory experiences on a 4-point Likert scale (3: “Nearly always” 2: “Often” 1: “Sometimes”, or 0: “Never).

Figure 2. Scatter-plot showing the relationship between total AVAQ and SPQ/AQ-scores.

Appendix I. Audio-Visual Abnormalities Questionnaire (AVAQ)

Instructions: For each question, indicate frequency over the past 1year. If you have not had this experience reply 'never' and we will move to the next question.

Never: I never had this experience/I have not had this experience in the past 1 year.

Sometimes: I occasionally had this experience in the past 1 year (1-2 times per month)

Often: I often had this experience in the past 1 year (1-2 times per week).

Nearly always: I nearly always had this experience in the past 1 year (daily).

1. Visual Processing

Light sensitivity and phosphenes or photopsias

1. Objects appear to be too bright.

2. I see flashes of bright light, stars, flames, or spots of varying shapes.

3. It is brighter outside during the day than in the evening. (catch)

Perceiving/recognizing objects (including shape perception)

4. When I focus on an object, it seems to briefly disappear and reappear.

5. When I see a common object from a strange or unusual perspective, I have difficulty in recognizing what it is.

6. When I see objects, I can see their parts, but those parts do not seem to fit together.

7. At night, I will mistake a shadow for being a real physical object even when I am fully awake.

8. It is hard to determine the shape of an object; I need to actually pick it up or look at it from different angles.

9. As I look at ordinary things like trees or clouds, patterns start to emerge out of nothing.

10. I can only see parts of an object; certain other parts that I know are there appear to be missing.

11. Objects that are completely separated appear as if they were connected.

Perceiving/recognizing faces (self and others)

12. When looking in the mirror, I know it is my face, but for some reason, my facial features look deformed.

13. When I am looking at a person I know, the coloring of their skin, eyes, or hair appears different.

14. When trying to recognize people, I can only see their individual facial features a nd I cannot seem to form an image of their face as a whole.

Perceiving/recognizing body parts other than faces (self and others)

15. My body looks like it is deformed even though I know it is not.

16. When I see myself in the mirror, my body looks like it is not mine.

17. Other people seem to have oddly shaped bodies.

18. People appear to be skinnier or more overweight than they actually are.

19. Everything seems so far away, as if it were way off in the distance.

20. Objects seem to be especially small, like they are small replicas of reality, but not the real thing.

21. Objects look like they are jumbo sized or too big, as if they were shown in a magnifying glass.

22. The world looks like it is flat to me; completely lacking in depth, as if I were looking at a painting.

23. It is harder to tell the fine detail of an object if it is very far away from me. (catch)

Other aspects of spatial vision

24. Things can appear lopsided, with one side bigger and one side smaller than they really are.

25. Straight or smoothly curved lines appear wavy.

26. Objects appear to be slanted or crooked, even when they do not actually have this property.

27. When I look at something, I seem to get stuck paying attention to the little details instead of looking at the whole thing.

28. The orientation of a line or shape is hard to see, for example, when trying to figure out whether a picture frame 0123 on the wall is straight or tilted.

29. Certain things appear to me to be upside down even though I know that they are not.

30. As I move away from an object, it seems like the actual physical size of the object is shrinking.

31. Even after looking at something for a while, I realize that there is a lot more there that I had not noticed.

Visual short term memory, iconic memory, and perception of persistence

32. I continue to see patterns or objects long after they are not there anymore.

33.When somebody waves around a light, especially at night, it seems to leave long trails behind it.

34. The world seems to jump around as I move my eyes from spot to spot; I need to keep my eyes steady to really see something clearly.

35. Words on a page seem to rearrange themselves even as I look at them.

Perception of motion, change, and event structure

36. Objects appear to move, as if there were a very mild earthquake that slightly shook everything back and forth.

37. When I am in a car or train, I feel like I am moving faster or slower than I really am.

38. Each moment seems to be disconnected to the next; it is almost as if frames of a movie were being removed from a film.

39. It becomes harder to make sense of things as I move my head or start walking around.

40. In very subtle ways, things seem to pulsate with energy.

41. The whole world seems like it is moving in slow motion.

Perception of visual number

42. I have double or triple vision, where I see the world repeated multiple times.

43. It is hard for me to tell right away how many objects that I am looking at, even when there are very few of them.

Color and Texture Perception

44. Everything I see is tinted in a certain color.

45. Colors seem paler or more washed out than usual.

46. Colors seem to be more intense or brighter than usual.

47. I have unexpected perceptions of where smooth objects appear rough or where rough objects appear smooth.

48. It is easier to tell the color of objects in a well-lit room than in a dark room. (catch)

Attention and scene perception

49. I get overwhelmed by everything I see.

50. As I look around, I am unable to tell the difference between what is important and what is not.

51. Everything that I see around me seems meaningful and worthy of my attention.

52. I find it hard to quickly absorb the overall meaning of a picture by looking at the whole thing.

53. Things or events in my peripheral vision catch my attention even though I do not want them to.

54. I feel like I have blinders on, not being able to notice what is going on in my peripheral vision.

55. I have a difficult time watching more than one or two things at a time, such as during a sporting event.

56. As I search for an object that I know to be in front of me, it takes me much longer than usual to find where it is.

Perception of animacy and biological motion

57. As I watch people walk down the street, they appear to move like robots.

58. When I see certain physical objects move around, they almost seem alive.

Audiovisual Processing

59. When I hear certain tones, voices, or music, I will see colors, shapes, or letters.

60. When I see certain things, I will hear tones, voices, or music.

61. My visual perception of objects is frequently disrupted by ongoing sounds.

Illusory Sounds

62. In my head, I hear sounds like cracking, clapping, humming, banging, whistling, hissing, or knocking, but I know they are not really there.

63. I hear vague animal sounds, such as bird noises, but soon after I realize nothing is really there.

64. I have heard people's cell phones ringing before. (catch)

65. I hear a ringing sound but it seems to come within my own head.

66. Distinct sounds and noises become fused together, as if they were all part of one thing.

Intensity and loudness (reduced or increased)

67. My hearing will cut out or stop working, like I am deaf momentarily.

68. When I am listening to music or someone talking, the sound becomes muffled, making it difficult to hear.

69. Ordinary sounds seem especially loud and bothersome to me even though they do not bother other people.

Frequency and pitch

70. Compared to other people, it's hard for me to tell just by listening whether something is approach or moving away, for example with an ambulance siren.

71. There are times where I cannot tell whether a person is asking a question or making a comment.

72. Sounds seem to be consistently pitched very low or very high.

Persistence or echoic memory

73. Sounds that I hear seem to echo for no apparent reason.

74. I continue to hear a sound linger, even though I know that the sound isn't occurring anymore.

Auditory scene analysis and auditory attention

75. When I hear many sounds at once, it is hard to really make sense of what is going on just by listening.

76. It is hard for me to focus on what someone is saying because other sounds (like other conversations or background noise) are distracting.

Sound localization

77. When I hear something, I cannot tell where it is coming from, even though others can do so.

78. When I walk down a busy street or within a crowded store, I hear one thing while everything else melts into the background.

79. It is hard for me to tell whether a sound is moving left to right or right to left.

Perception of music

80. Sounds that I used to enjoy, like music, seem odd and distorted.

81. I have listened to songs before. (catch)

3.8 Perception of speech and prosody

82. When I talk to people on the telephone, I have difficulty in figuring out if they are being sarcastic.

83. Words and sentences sound broken up or disconnected; it is difficult to put them together to understand what people are saying.

84. I have trouble following someone who speaks quickly; only when they slow down can I understand.

85. My own speech sounds to me like it is harsh, hollow, metallic, or far away.

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