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Brief article

Lexical effects on speech perception in individuals with "autistic" traits

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ABSTRACT

It has been claimed that Autism Spectrum Disorder (ASD) is characterized by a limited ability to process perceptual stimuli in reference to the contextual information of the percept. Such a connection between a nonholistic processing style and behavioral traits associated with ASD is thought to exist also within the neurotypical population albeit in a more subtle way. We examined this hypothesis with respect to auditory speech perception, by testing whether the extent to which phonetic categorization shifts to make the percept a known word (i.e., the 'Ganong effect') is weakened as a function of autistic traits in neurotypicals. Fifty-five university students were given the Autism-Spectrum Quotient (AQ) and a segment identification test using two word-to-nonword Voice Onset Time (VOT) continua (*kiss-giss* and *gift-kift*). A significant negative correlation was found between the total AQ score and the identification shift that occurred between the continua. The AQ score did not correlate with scores on separately administered VOT discrimination, auditory lexical decision, or verbal IQ, thus ruling out enhanced auditory sensitivity, slower lexical access or verbal intelligence as explanations of the AQ-related shift in phonetic categorization.

1. Introduction

Autism Spectrum Disorder (ASD) represents a spectrum of disorders characterized by a triad of impairments in social, communicative, and imaginative activities (Wing, 1981). Cognitive models have attempted to explain aspects of the profile associated with ASD. One theory, Weak Central Coherence (WCC) suggests that those with ASD have a style of processing which results in a weakening of the ability to integrate information into a meaningful whole or a 'gestalt', while the ability to focus on the detail is preserved or even enhanced (Happé & Frith, 2006). WCC receives empirical support from a number of characteristics associated with ASD, including resilience to visual illusions induced by embedding (Happé, 1996), facility in visual segmentation (Shah & Frith, 1993) and high incidence of absolute pitch (Heaton, Hermelin, & Pring, 1998). Similar tendencies have been reported in linguistic tasks, where autistic individuals tend not to employ semantic context to disambiguate homographs (Happé, 1997) or sentences (Jolliffe & Baron-Cohen, 1999).

Findings such as these suggest that people with ASD may also display dissociation between detail/local vs. contextual/global information in lower levels of linguistic processing such as speech perception. As the existing evidence indicates that the effects are most likely to occur in areas where semantic information offers a backdrop for processing, we have turned our attention to the influence of lexical knowledge on phonetic categorization.

Auditory speech perception is known to be affected by the lexical status of a phonetic sequence. In a seminal study, Ganong (1980) demonstrated that listeners shift their segment identification along a Voice Onset Time (VOT) dimension to make the percept a real word rather than a nonword (e.g., *kiss* vs. *giss*). This process can be seen as a form of central coherence in that the lexical context of the sound influences the perception of the auditory stimulus top-down. We thus predict that this effect will be

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attenuated in people with autistic traits. In this study, we elected to test this hypothesis within neurotypical individuals, taking their Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) as a predictor variable. The motivation behind our decision to test neurotypicals was threefold. First, WCC hypothesizes that the balance between local and global (bottom-up vs. top-down) processing is a matter of style rather than deficit (Happé & Frith, 2006). In other words, the extent to which individuals focus on local information at the expense of global integration forms a single continuum that includes neurotypicals as well as those who display ASD (Baron-Cohen et al., 2001). Second, impairments in language are one of the core features of ASD (American Psychiatric Association, 1994), which potentially affects their lexical knowledge and access. Our aim was to examine how a similar level of lexical information can affect phonetic processing to different degrees depending on the individual's autistic traits. We therefore reasoned that it would be informative to study a homogeneous sample of neurotypicals, whose lexical knowledge and access can be assumed to be less variable than that of the ASD population. In addition, by assessing whether certain social, communicative, and imaginative traits in neurotypical individuals are associated with phonetic perception, we would be able to examine the extent to which individual differences in personality have any bearing on a basic cognitive process such as auditory speech perception. If a relationship is found, it will have significant implications for the intensely debated domain-specificity of speech processing as a cognitively distinct module (e.g., Kluender, 1994; Liberman & Mattingly, 1985; Trout, 2001).

In order to scrutinize the hypothesis that the phonetic processing of individuals with high AQ is less affected by lexical information due to weak central coherence, we also examined other ways in which attenuated lexical effects in phonetic processing may be related to high AQ. First, it is possible that individuals with high AQ possess high auditory sensitivity or enhanced perceptual processing (Mottron, Dawson, Soulieres, Hubert, & Burack, 2006), which may lead to robust phonetic discrimination abilities that are immune to lexical effects. There is currently no conclusive evidence in support of such auditory sensitivity in autism (Rogers & Ozonoff, 2005). However, there is some evidence suggesting that individuals with autism show enhanced discrimination of pure tones (Bonnel et al., 2003). Given our still poor understanding of the nature of sensory features in autism, we opted to examine this possibility by testing our participants' ability to discriminate the relevant acoustic differences.

Second, it may be the case that high AQ is connected to slower lexical access, as some individuals with ASD are known to have language impairments. This in turn can reduce the effects of the lexical status of the phonetic stimuli. To check against the possibility that AQ is confounded with lexical access, we also administered a lexical decision task.

In addition, there is the possibility that the degree of lexical involvement in a perception task may be influenced by the listeners' verbal intelligence. This could result in a correlation between AQ and lexical effects, since autistic individuals have been associated with an IQ profile with a relatively low score on verbal IQ in comparison to performance IQ (Rumsey, 1992; Yirmiya & Sigman, 1991). Therefore, we have also attempted to examine the contribution of verbal IQ, in this case measured by the Mill Hill Vocabulary Scale (Raven, Court, & Raven, 1988).

In sum, the main purpose of this study was to test the hypothesis that individuals with high AQs tend not to be influenced by lexical contexts in their phonetic speech perception. A secondary purpose of the study was to examine the potential contributions of factors that are extraneous to the integration of lexical knowledge and phonetic information.

2. Methods

2.1. Participants and general procedure

Fifty-five undergraduate students at a British university, all native speakers of English, took part in the study as part of a psychology course. Their age range was 18–33, with a mean of 21.4 ($SD = 3.2$). Thirty-seven of them were female and 18 were male. All participants were given five tasks: an identification task with word-to-nonword continua, an ABX discrimination task with a nonword continuum, a lexical decision task, the AQ test, and the Mill Hill Vocabulary Scale test.

2.2. Word-nonword continuum identification

2.2.1. Materials

Two word-to-nonword VOT continua were produced by digitally cross-splicing naturally spoken tokens of *gift* and *kift*, and *kiss* and *giss*, respectively. The original tokens were read by a male British received pronunciation (RP) speaker, and recorded at a sampling rate of 48 kHz. The initial proportions of *kift* and *gift* were replaced by those of *kiss* and *giss*, respectively, such that the endpoint pairs were acoustically identical up to 100 ms after the onset. These tokens were then cross-spliced to produce two equal-step 7-point continua ranging from *gift* to *kift* and from *giss* to *kiss*. The VOTs at endpoints were 8.77 ms and 65.60 ms, respectively, and each step was approximately 9.46 ms with some minor adjustments made in order to enable splicing at zero-crossings. The stimuli were down-sampled to 11 kHz before they were mounted on a stimulus presentation program (E-Prime).

2.2.2. Procedure

The participants listened to the recorded stimuli played on a computer over headphones and pushed the *g* or *k* key to indicate their impression of the first segment of each stimulus. The session consisted of two blocks of trials. In each block, all 14 stimuli were presented 4 times in a random order. Each stimulus was therefore played 8 times (4 times $\times$ 2 blocks).

2.3. Nonword ABX discrimination

2.3.1. Materials

A 9-step continuum was created using a Klatt synthesizer (SenSyn version 1.1). Each utterance was 250 ms long and