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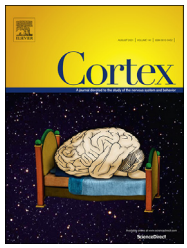

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Detection without further processing or processing without automatic detection? Differential ERP responses to lexical-semantic processing in toddlers at high clinical risk for autism and language disorder

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ABSTRACT

Delays in early expressive vocabulary can reflect a specific delay in language acquisition or more general impairments in social communication. The neural mechanisms underlying the (dis)ability to establish the first lexical–semantic representations remain relatively unknown. Here, we investigate the electrophysiological underpinnings of these mechanisms during the critical phase of lexical acquisition in two groups of 19-month-old toddlers at risk for neurodevelopmental disorders, i.e., children characterized by low expressive vocabulary (late talkers, N = 18) and children with early signs of Autism Spectrum Disorder (ASD, N = 18) as compared to typically developing children (N = 28), with the aim to identify similarities and specificities in lexical-semantic processing between these groups. ERPs elicited by words (either congruous or incongruous with the previous picture context) and pseudo-words are investigated within a picture-word matching paradigm. In order to further interpret ERP responses, we look at longitudinal intra-group associations with language and socio-communications skills at age 24 months.

As expected, we found differences between the groups that might underlie specificities, but also similarities. On the one side, late talkers differed from the other two groups in the early component (phonological-lexical priming effect) reflecting detection of the correspondence between the heard word and the lexical representation pre-activated by the picture. On the other side, children with early symptoms of ASD differed from the other two groups in the late component (late positive component) reflecting the effortful semantic re-analysis following a violation. The functional interpretation of the two components is corroborated by significant correlations suggesting that the early component is associated with later socio-communication skills, whereas the late component is associated with linguistic skills. Results point in the direction of differential impaired

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mechanisms in the two populations, i.e., impaired automatic detection of incongruencies in late talkers vs. absence of high-level re-analysis of such incongruencies in children with early signs of ASD.

1. Introduction

The course of typical language development is laid out as a sequence of linguistic milestones characterized by wide variation regarding the age at which they are reached. During their first years of life, children learn to recognize words in the continuous stream of speech and to map sounds onto meaning in order to associate words with their referents (Guasti, 2017). These processes become apparent around the end of the first year, when most infants start to produce their first identifiable words. Late in the second year, most children can master around 50 to 100 words, start to combine them into short utterances and experience a sudden rapid increase in the vocabulary called "vocabulary spurt". Delays in meeting these early linguistic milestones—and specifically delays in expressive language—are among the most common reasons for diagnostic evaluation (Ellis & Thal, 2008; Whitehurst & Fischel, 1994). These symptoms might be a first sign of a neurodevelopmental disorder, including developmental language disorder (DLD), intellectual disability, or autism spectrum disorder (ASD) (Morgan, Delehanty, Cleary Dillon, Schatschneider, & Wetherby, 2020; Rescorla, 2011).

A substantial portion of toddlers who are referred to clinical services for delays in early vocabulary skills are found to be "late talkers", a term used to describe children in their second year or early in the third year with unusually small expressive vocabularies. These children appear to be developing normally but acquire words very slowly and do not begin combining words at the typical age. Some late talkers do only have an expressive delay, whereas others are delayed in receptive language as well. Although prognosis for late talkers is good, with more than half of these children moving into the average range on language measures by preschool (Dale, Price, Bishop, & Plomin, 2003; Dollaghan, 2013), these children as a group are at increased risk for persistent language difficulties and DLD than the general population (Paul, 2000; Rescorla & Dale, 2013). Buschmann et al. (2008) analyzed 100 two-year-olds referred to pediatric practices because of delayed expressive language and found that 78% were identified as "late talkers". Among this sample, 4% of the children fulfilled the diagnostic criteria for childhood ASD, a lifelong neurodevelopmental condition characterized by difficulties with social communication and interaction and restricted and repetitive patterns in behaviors, interests, and activities (American Psychiatric Association, 2013).

Even if language delays are not included in the DSM-5 as a diagnostic criterium, deficits in language skills in the first years of life are a hallmark feature of ASD. According to reports, children with ASD do not only utter their first words (Charman et al., 2003; Matson, Mahan, Kozlowski, & Shoemaker, 2010) and utterances (Grandgeorge et al., 2009; Kenworthy et al., 2012) later but also show smaller receptive vocabularies, more superficial definitions of words, and poorer understanding of relatedness between words compared to their typically developing peers (Boucher, 2011; Haebig, Kaushanskaya, & Ellis Weismer, 2015; Henderson, Powell, Gaskell, & Norbury, 2014; McGregor & Bean, 2012). Although many typical symptoms can differentiate children with early signs of ASD from late talkers (i.e., lower degree of spontaneous pretend play, expression of joint attentional intentions and use of conventional gestures and greater extent of repetitive movements and unusual vocalization, Paul, Chawarska, & Volkmar, 2008), the two populations show striking similarity if only the observed language impairment is considered.

In the present study, we investigate the neural mechanisms underlying lexical-semantic processing in the two populations as compared to typically developing peers. In particular, it seems important to determine whether the brains of these young children in the early phases of language acquisition work differently when processing words in meaningful contexts.

Unique insight into early language skills can be accomplished by measuring activity in the brain by means of event-related potentials (ERPs) during a comprehension task. In children younger than two, comprehension of word meaning has often been studied by recording ERPs to verbal stimuli in picture-matching paradigms (Friedrich & Friederici, 2004, 2005a, 2005b, 2006, 2008, 2010; Cantiani et al., 2017; Duta, Styles, & Plunkett, 2012; Junge, Cutler, & Hagoort, 2012; Torkildsen et al., 2006). In these paradigms, children are passively shown a picture (for example, a picture of a cat) followed by an auditory label that either does (match condition—the word "cat") or does not match the picture (mismatch condition—the word "shoe"). The same paradigm can also be used to investigate how the child's brain processes words without meaning, which can be phonotactically legal, i.e., pseudo-words, or illegal, i.e., non-words (Cantiani et al., 2017; Friedrich & Friederici, 2005a). Specific ERP components have been reported when the heard word did/did not match the picture presented on-screen and when an unknown word is paired with the same picture.

First, an enhanced negativity in frontal brain regions around 100–500 ms called the "*phonological-lexical (PL) priming effect*" (e.g., Friedrich & Friederici, 2006) has been reported in response to words that correctly named the pictures, when compared to the same words within incongruous picture contexts (Friedrich & Friederici, 2004, 2005a, 2005b). It has been suggested that the picture content might create lexical expectations and that the PL priming effect reflects the improved phonological processing driven by the correspondence between the heard word and the