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Chapter IV

"No Time Like the Present": Time Perception in Autism

Melissa J. Allman*[*1] and Iser G. DeLeon[2]
[1] The Kennedy Krieger Institute and Johns Hopkins University School of Medicine
[2] The Kennedy Krieger Institute and Johns Hopkins University School of Medicine

Abstract

The terms 'autism' and 'autistic' derive from the Greek word *autos* meaning self. This is appropriate to describing the autistic behavioral phenotype in which there is a pathological impairment in socialization and verbal and nonverbal communication, in addition to behavior and interests that are often highly restricted and repetitive (the triad; American Psychiatric Association, 1994). The autistic individual often appears isolated, and unable to make sense of the world around them. They often reveal an inability to predict and understand the behavior of others, and perceptions of the world remain fragmented and are not embedded into a coherent pattern or structure. Time is part of the fundamental intellectual structure in which we make sense of the events in our lives. 'Timing and time perception allow us to unite action sequences and events occurring separately in time, to adapt to

[*] Address correspondence to: Melissa J. Allman; Department of Behavioral Psychology ; Kennedy Krieger Institute; 707 N. Broadway; Baltimore, MD 21205

reoccurring situations, and to predicate behavior on what is expected to occur'. Timing and time perception are essential for adaptation and learning, memory and attention, cognitive development, and social synchrony and communication (see Meck, 2003). Firsthand accounts of people with autism often report a need to adhere to rituals or routines to compensate for a failure to predict events, and to their disorientation in time. They reveal a general lack of understanding about the passage of time, and appear stuck in the present. It is for these reasons that the issue of timing and time perception in autism is particularly intriguing. We will review empirical evidence that collectively suggests time perception may be disordered in autism, and postulate that fundamentally, a disturbed 'time sense' may contribute to features of the autistic behavioral phenotype.

Introduction

Time is an omnipresent feature of the human experience, and accordingly has been the subject of enquiry since the dawn of civilization (e.g., Saint Augustine, 397/398 AD) and the advent of modern psychology (e.g., James, 1890; see Fraisse, 1963 for a review of debate about time perception over 25 centuries). Time is so fundamental to our understanding of the world that it is difficult to imagine a world without it. Imagine if you could not represent the length of a minute, a year, or were unable to anticipate the impending change of a traffic light, or the length of a movie (how would you know that once started it would come to an end?). 'Our capacity to perceive temporal structure and our sensitivity to time on multifarious scales; from short durations (i.e., milliseconds and seconds) to long durations (e.g., hours and days), at perceptual, conceptual and linguistic levels, is central to our adaptive functioning, and all behavior is ultimately under the control of time' (Michon & Jackson, 1985). These authors assert that time "occupies a central position in our cognitive representations of reality" (1985, p. 3), and time is widely regarded as the most important dimension by which we make sense of the world (Navon, 1978).

Relatedly, there are anecdotal and clinical reports that individuals with autism experience difficulty in comprehending the passage of time, and this has a significant impact upon how they perceive the world (see Boucher, 2001). "Concepts of time have always puzzled and fascinated philosophers but most people are born with the ability to understand it in everyday terms. People with autistic disorders seem to lack this understanding to a degree that is markedly discrepant with their level of intelligence" (Wing, 1996: 89). Remarkably, very

little empirical attention has been paid to examining time perception in autism (but see Boucher, Pons, Lind & Williams, 2007; Szelag, Kowalska, Galkowski & Poppel, 2004). This chapter will introduce elements in the typical development of time perception during infancy and childhood, and will review evidence that indicates these may be impaired in autistic individuals. It will speculate on how a disordered 'time sense' may contribute to the triad of autistic impairments.

Typical Development of Time Perception During Infancy

Developing an understanding of temporal structure has been postulated to depend upon any number of 'time experiences', a comprehensive discussion of which is beyond the scope of this chapter (but see Friedman, 1982; Lewkowicz, 1989; 1992; Poppel, 1978). Suffice to say here, that duration, synchrony, order, and 'past and present' appear to be key elements that lay the foundation for the perception and representation of time. Each of these elements will now be discussed in relation to autism.

Duration

The developmental psychology of time perception postulates that awareness and knowledge about temporal duration emerges from intrinsic biobehavioral rhythms and early action (Lewkowicz, 1989). The temporal regulation of rhythmic stereotypies displayed by infants (see Thelen, 1981) has been postulated to facilitate their adaptation to the temporal contingencies of their physical and social environments (Droit & Pouthas, 1992). Furthermore, especially in the early years, repetitive motor actions may themselves serve to measure the duration of events. Pouthas (1985) observed that when typically developing 10-24 month olds were required to withhold responding for a target delay (i.e., 5 s), they did so by adopting repetitive actions during the interval (i.e., they engaged in body-rocking or moved around the room in a certain fashion), but in older children between the ages of 4-7 yrs, manifestations of this 'behavioral clock' were significantly reduced (Pouthas & Jacquet, 1987). It appears that reliance upon motor actions to estimate duration may be supplanted (during development) by more cognitive processes. In a similar vein, mentally retarded children aged 6-17 (with an IQ between 29 & 48) can reproduce a given duration as accurately as typically developing children aged 3-6 years, if they are allowed to engage in repetitive

behaviors (and have rhythmic structure) during the interval (see Fraisse, 1982). Perhaps then, a failure to acquire an understanding of duration and temporal contingencies accounts for the persistence of stereotypic behaviors in autistic individuals into adult life. This tenet is strengthened by empirical evidence (Szelag et al., 2004) that high-functioning children with autism (9-16 yrs) are severely impaired in their ability to reproduce target durations (between 1-5 s) compared to age-matched typically developing controls. These authors explicitly attribute such failures to deficits in the autistic internal timing system. An impaired understanding of duration is also revealed by the autistic "lack of awareness that an event, once started, will come to an end" (Wing, 1988, p. 88).

Synchrony

Synchrony is considered one of the first features of temporal experience to be differentiated by an infant (Lewkowicz, 1992). Here, we will refer to two aspects of synchrony: interactional synchrony (the ability to adapt to a temporal structure or coordinate with external events), and intermodal synchrony (the ability to perceive temporal synchrony in events occurring at the same time), both of which can be acquired during parent/infant interactions. It has been postulated that the temporal patterning of a parent's communication toward the infant is the most important aspect of these interactions for the child, and allows them to acquire an understanding of temporal expectancies and structure (Stern, Beebe, Jaffe & Bennet, 1977). An infant's ability to temporally coordinate his or her behavior with that of another person is key to preverbal and verbal interactions, in which turn-taking must be accurately timed (Trevarthen & Aitken, 2001). From birth, infants are typically able to synchronize with certain aspects of their parents' communication (Malloch, 1999), and exquisite reciprocal behavioral rhythms and regularities are observed during parent/infant interactions (for details, see Lester, Hoffman & Brazelton, 1985). However, asynchronous social coordination (during these interactions) has been retrospectively observed in 11-month-old autistic infants (Trevarthen & Daniel, 2005; see also Kubicek, 1980). Moreover, the discrimination of temporal synchrony between intermodal events (i.e., the sight and sound of the parent's speech) during parent/infant interactions "may be the first step in developing a capacity to discriminate more complex and specific forms of language" (Bebko, Weiss, Demark & Gomez, 2006, p. 96). These authors report that autistic children (aged 4-6 yrs) reveal atypical responding to mutimodal temporal asynchrony with language-specific stimuli. Collectively,

these findings lend support to the suggestion that an understanding of temporal synchrony may be impaired in autistic individuals.

Order and 'Past and Present'

The order of successive or serial events is a fundamental aspect of temporal structure, and also provides information as to the causal relationships between events. Harner (1982) asserts that two types of seriation exist. The first is the relative position of two events on a time continuum (i.e., one event precedes the other). This form of knowledge about temporal order is likely spared in autism, as paired-associate learning and linear sequencing of successive items is typically intact (Kanner, 1943; Minshew, Goldstein & Siegal, 1997) and is commonly evidenced by echolia, and rote learning for phrases or songs (Boucher, 2001). This type of 'temporal stringing' has been argued to depend upon linear (or circular) visual representations of temporal order (Friedman, 1990). This is interesting in relation to autism, as Temple Grandin, one high profile autistic individual reports "my mind is like a…quick access videotape. But [in order to remember an aspect of an event] I have to play the whole part—no fast forward" (Sacks, 1995, p. 269). However "it seems that people with autistic disorders have severe problems coping with sequential events that have no independent, concrete existence" (Wing, 1988, p. 89), so a child may have difficulty understanding the concepts of 'yesterday', and 'tomorrow', unless these are concretized by showing them a calendar and the relevant dates. This is evidenced by the popularity and success of picture schedules (of temporally sequenced events) in the training and treatment of children with autism (e.g., Lalli, Casey, Goh & Merlino, 1994; MacDuff, Krantz & McClannahan, 1993). The second aspect of seriation is the position of events in the overall time continuum; although two events will maintain a consistent relation to one another, their inclusion in the before or after; or past, present and future categories of experience is transitory (e.g., tomorrow becomes yesterday). A sensitivity to this more complex form of sequential structure is considered crucial for action knowledge, object use, drawing inferences from others actions, and planning one's own behavior (Baldwin, Baird, Saylor & Clark, 2001; Zalla, Labruyere & Georgieff, 2006). This type of hierarchical temporal coding is likely deficient in autism (see Boucher, 2001, p. 113). For instance, it has recently been reported (Boucher et al, 2007) that children with autism (7-16 yrs) reveal marked impairments in diachronic thought. That is, they are unable to i) think about past or future stages of current situation,

ii) understand that things can change or evolve over time but are still the same thing, and iii) that successive events are part of a unitary process (see also Montangero, 1992).

How a Disorder of Time Perception May Contribute to the Autistic Behavioral Phenotype

It is difficult to know with any degree of certainty how a disordered sense of time might impact behavioral and cognitive function, but is easy to speculate. That the products of this speculation so closely resemble features of the autistic behavioral phenotype is particularly striking.

Restricted and Repetitive Behaviors

Janet (1928) noted that one of our earliest experiences with time (duration) arises during periods of waiting, when there is an imposed delay between our desires and their satisfaction. An inability to wait represents a deficit in linking the passage of time with ongoing activities, and is a common problem for autistic children and adults (Wing, 1988). "Impatience is common in all young children but in people with autistic disorders it can continue for years, even into adult life" (1988, p. 88). Recall that in one study (Pouthas, 1985), waiting in young children was facilitated by their adoption of repetitive behaviors (e.g., stereotypies) that functioned to parse the delay interval. That stereotypies can function as a 'behavioral clock', suggests that a failure to understand the passage of time (duration) may account for the persistence of certain repetitive behaviors in autism. Stereotypies are typically produced in repeating cycles, and may be seperated by (often short) intervals in time—continually measuring intervals in a repeating cycle requires less attentional resources (Lewis & Miall, 2003), and so repetitive motor behaviors may be a particularly effective time-parsing stratergy for autistic individuals, and might function to concretize and reduce the stressor of an imposed disorientation in time. Peeters and Gillberg (1999, p. 87) report that "most people with autism feel lost in a sea of time…they will often try to develop routines and rituals by way of compensation. They want all activities to be undertaken in the same sequence every day…and if the sequence of activities changes on a certain day, then they have behavior problems" [which can include rhythmic lower-order motor behaviors, e.g., head-banging, self-injury]. To

reiterate the main point here, an autistic impairment in the perception of duration may be compensated for by the production of repetitive motor behaviors (such collateral behaviors are often observed during superior temporal performance in animal studies), and an overreliance upon intact abilities, such as sequencing and order, and the stringing together of temporal units of perseveration or habits.

One very interesting possibility was considered by Boucher (2001). In her own words, "try to imagine periods of time longer than the lifetime of the universe…in fact, one cannot imagine a period of time longer than the lifetime of the universe except by thinking of a temporal succession of universes with cumulative lifetimes" (2001, p. 121). She suggests that there may be a close correspondence between the length (and complexity) of repeating behavioral units (e.g., stereotypies, rituals) and the ability to imagine extended time frames in autism. As shorter and less complex stereotypies are usually observed with lower-functioning autistic individuals, and more complex, rigid routines are observed in those who are higher functioning, it follows that the ability to perceive duration might account for quantitative and qualitative differences in repetitive behaviors across the autistic spectrum (Boucher, 2001).

Language and Social Communication

Selective impairments in the autistic child's' ability to temporally coordinate to their social environment and to represent the temporal structure of their social and physical world, may explain the lack of interest in social interaction from the first year of life which parents of autistic children typically report (Wing, 1988). It may also contribute to these individuals retreating into their own 'inner world' (aloofness), and explain their preoccupation for repeating or rhythmical sensory stimulation (e.g., Grandin, 2005). Autistic deficits in acquiring knowledge from these early 'time experiences' (e.g., synchrony, duration) might produce a cascade of other autistic deficits (a full discussion of which is beyond the scope of this chapter). For example, we have seen that "in speech perception, temporal factors such as synchrony, duration, rate and rhythmic structure play an important role in the integration of the visible and audible aspects of the signal" (Lewkowicz, 1992, p. 34). Generative language production and comprehension is heavily dependent upon a multitude of temporal competencies, and with its immanent references to time (e.g., past, present and future tenses), language may become an irreconcilable code for an individual who lacks temporal fluency, as we postulate in autism.

The Autistic Perceptual Experience

Our subjective experience of duration is fallible, and can be influenced by a variety of factors (such as the content of the interval, drugs, and body temperature, e.g., see Meck, 2003). The popular phrase 'time flies when you're having fun' is testament to this quality of duration perception. There is also a debated phenomena known as 'time dilation'. This refers to the sensation that time can appear to slow down, or pass by in slow motion (particularly during periods of heightened arousal). When Alice fell down the rabbit hole at the beginning of her adventures in Wonderland, "either the well was very deep, or she fell very slowly, for she had plenty of time as she went down to look about her, and to wonder what was going to happen next" (L. Carroll, 1992). We might be familiar with a similar experience when our car starts to skid off the highway at speed. This phenomenon of time 'warping' is believed to be the product of an increase in the speed of the internal timing apparatus (and is currently being investigated by D. M. Eagelman and colleagues). It may be biologically adaptive, as it appears to produce a hypersensitivity to sensory events, and prompts an elemental rather than configural processing bias that serves to facilitate decision-making ability. During these moments, the individual is also 'stuck' in the subjective time present. In light of the fact that autistic individuals appear to experience qualitative differences in sensory perception (Grandin, 2005) it is possible that the subjective experience of time is more mercurial to intrinsic and/or extrinsic variables in people with autism; with the 'speed' or function of the internal timing apparatus being different or more variable in these individuals. Within this conceptual framework, lower-order rhythmic motor behaviors may function to regulate and stabalize the subjective perception of duration. Furthermore, if the perception of duration is anomalous between different sensory modalities in autism (i.e., visual and auditory; see Penney, Gibbon & Meck, 2000) then this may produce problems with intersensory integration (and intermodal synchrony), and the binding of external inputs into meaningful information (e.g., see Brock, Brown, Boucher & Rippon, 2002).

Conclusion

The interest in understanding time perception in normal and patient populations (including conditions co-morbid with autism) is growing rapidly

(e.g., Toplack, Dockstader & Tannock, 2006), yet the paucity of empirical data relevant to autism is particularly striking (Boucher et al., 2007) given anecdotal reports that 'whatever *it* is that typically developing individuals posses that gives them a sense of timing we, as individuals with autism certainly lack it' (Lawson, 2001, p. 43). This chapter, and those studies which it cites, have elucidated how deficits in the experience of time may contribute to the autistic behavioral phenotype (the triad; APA, 1994). Pursuing this line of enquiry may enhance our understanding of this perplexing disorder, and advance extant interventions and strategies designed to concretize the passage of time for autistic individuals. An autistic preoccupation with timetables, clocks and calendars is common and may be particularly useful in helping autistic individuals to understand time (Wing, 1988). For example, it would be of particular interest to examine whether devices such as the Time Timer™ are effective in reducing repetitive behaviors during periods of waiting. Given that sensitivity to the temporal parameters of experience can be evidenced within the first year of life, it may also be worthwhile to incorporate assessments of temporal competence into early-year studies of at-risk autistic infants, in the hope that they may provide some predictive power as to later diagnosis.

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"No Time Like the Present": Time Perception in Autism. Chapter. Full-text available.Â 'Timing and time perception allow us to unite action sequences and events occurring separately in time, to adapt to. View. Show abstract.Â The aim of the present study was to investigate whether children with Autism Spectrum Disorders (ASD) have a deficit in time perception. Twelve ASD children of normal intelligence and twelve typically developing children (TD) - matched on sex, chronological age, and mental age - performed four temporal bisection tasks that were adapted to the population. Two short (0.5 to 1 s and 1.25 to 2.5 s) and two long duration ranges (3.12 to 6.25 s and 7.81 to 16.62 s) were thus examined.