Published in final edited form as:

Soc Dev. 2016 November ; 25(4): 687–703. doi:10.1111/sode.12174.

Conceptualizing Social Attention in Developmental Research

Brenda Salley^{1,2} and John Colombo¹

¹University of Kansas

²University of Kansas Medical School

Abstract

The term social attention has become widely used during the last decade, appearing within behavioral neuroscience and developmental neurocognitive literatures to characterize a variety of activities and cognitive processes that emerge in the presence of conspecifics. We provide here an overview of the current status of social attention as a construct, as reflected in its appearance in research studies, and we offer a framework for characterizing the extant literature based on the functions of social attention processes: as behavior for social communication, as motivation to engage in social communication, and as a form of basic visual attention in the context of other social agents. We then provide two overarching questions to guide future research efforts directed toward establishing the utility of social attention as an independent and/or unified construct. We then consider implications and recommendations for future research efforts.

Keywords

social attention; joint attention; visual attention; social motivation; conceptual review

Introduction

Social attention is a term that has appeared with increasing regularity within the behavioral neuroscience and developmental neurocognitive sciences during the last decade. The construct appears to have gained traction due to heightened interest in cognitive processes within social contexts, especially as applied to atypical developmental outcomes.

A literature search using the keywords ‘social attention’ highlights the heterogeneity with which the phrase is used, as well as the relative lack of consensus on its meaning and referents both within and across disciplines. As we will describe in the following discussion, social attention has been used broadly as a synonym for nonverbal social communication behaviors (i.e., joint attention behaviors including eye contact and gesture used for the purpose of coordinated social attention sharing with others), to characterize attention preferences to faces during the first year of life, and to contrast typical and atypical social

Correspondence should be addressed to Brenda Salley, Department of Pediatrics, University of Kansas Medical School, KS 66160, USA. bsalley@kumc.edu.

Additional Supporting Information may be found in the online version of this article at the publisher’s web-site:

Table 1. Findings of a Literature Review on Use of the Term “Social Attention” Within Developmental, Clinical, and Behavioral Neuroscience.

motivation with others (i.e., the deficits in social communication and social interaction observed among clinical populations such as individuals with autism spectrum disorder). In some cases definitions have been offered, but the term social attention is used most often as a generally recognized concept without explicit definition. Our purpose here is to highlight the current state of the construct of social attention as it has been used and characterized in the literature. To do this, we first provide an overview of articles that have used the term social attention either conceptually or empirically. We then consider implications of that usage and draw recommendations for future research. Note that our goal here is not to resolve issues emerging within different literatures in the context of social attention, but rather to characterize current uses of the term. It is our hope that this framework will advance progress in conceptual and empirical consideration of social attention within the developmental sciences.

Framework for the Discussion

The term social attention has appeared most within the developmental, clinical and behavioral, cognitive, neurobiology, and comparative literatures. We conducted a PubMed, PsycInfo, and Web of Science search of all English-language articles, published before December 2014 with the search phrase ‘social attention’ appearing in the title or text of the article. These searches generated 233 articles initially, 132 of which were identified as conceptually appropriate for consideration here (see literature included in Supporting Information).

The present discussion includes articles that have a conceptual focus on *social attention activity produced by the individual*. More specifically, the emphasis here is on the activity or processes of social attention *per se* rather than the products or other behavioral outcomes that may derive from social attention. We excluded articles reflecting the following fundamentally distinct conceptualizations of social attention:

1. social and personality literature referencing effects elicited by the presence of social observers (e.g., social blushing, inter-personal factors);
2. applied behavior analytic literature referencing the reinforcing value of others’ attention for problem behaviors (e.g., functional analyses);
3. geriatric psychology literature referencing social supports in treatment;
4. social policy statements.

What remained were theoretical and empirical studies that ranged from use of social attention as a broad umbrella term for attention to other people to more narrowly defined behavioral measures (e.g., gaze following). Although the term ‘social attention’ first appeared in 1968 within the behavior analysis literature (Reynolds & Risley, 1968), the term social attention as conceptualized here made its first appearance in the mid-1990s in a comparative study of non-human primates (Pineda, Sebestyen, & Nava, 1994) but then not again until 2000 in the joint attention literature (Mundy, Card, & Fox, 2000), after which a steady increase in use occurred within clinical, developmental, and cognitive neuroscience

literatures. To place this increase in perspective, more than 50% of the articles considered here were published between 2010 and 2014.

Presently, there is no consensus on how the term social attention should be defined or measured (but see Birmingham & Kingstone, 2009; Kingstone, 2009; Risko, Laidlaw, Freeth, Foulsham, & Kingstone, 2012 for related discussions). Although the term social attention has not always been explicitly defined, our analysis of the literature suggests that it has generally been used in one of three broad domains.

Perhaps the most prominent use of the term social attention has been as a synonym for nonverbal social communication, or joint attention behaviors. In fact, joint attention is often defined as ‘the capacity for social attention coordination’ (Mundy et al., 2000, 2007). A related appearance has been within clinical research, which has characterized dysfunction in social attention (i.e., social awareness, face/emotion processing, decoding social cues) in clinical populations, most frequently autism spectrum disorder (ASD) (e.g., Dawson, Toth, et al., 2004). Finally, developmental research has long considered the early attention preferences of infants (e.g., for faces, voices, etc.) and has begun to examine general visual attention to conspecifics, work which has recently been reframed as indicators of social attention (for example see Perra & Gattis, 2010).

For the purpose of illustrating conceptual and methodological differences, we suggest that current usage of the term can be distilled into three functional categories. First, social attention can be considered in terms of *behavior* directed toward coordination of attention during interaction with others (i.e., joint attention or nonverbal social communication behaviors). Second, social attention can be considered as *motivation* to engage with others, including atypical populations with possible deficits in motivation for social engagement (i.e., ASD). Third, social attention can be considered as *attention* (orienting, focusing and disengagement of visual systems) in the context of social streams of information. The literature referencing social attention is briefly considered below, categorized by function as a means of advancing our conceptualization of what social attention may (or may not) be. We do not propose these categories are independent in function, indeed, we find it more likely that they are inter-related. Our discussion here is not meant to provide a comprehensive review of the findings within these literatures (although we point the reader to relevant reviews), but rather to identify representative studies that highlight each perspective. Studies reviewed are summarized in the Supplemental Materials in table form (including study purpose; major findings; operationalization of social attention; definition of social attention, if given; and functional categorization based on the conceptual approach described below).

Conceptual Approaches to Social Attention

Social Attention as Social Behavior (Joint Attention)

The term ‘joint attention’ entered the research literature on language and symbolic thought in the 1960s and 1970s and became conceptualized as the foundation for socioemotional and language development (Bates, Camaioni, & Volterra, 1975; Bruner, 1976). Joint attention is used to describe a functional construct (e.g., shared attention state between two persons

focused on an object/event of interest) and nonverbal social communication behaviors (e.g., eye gaze, pointing/showing gestures; gaze following) that serve various communicative/inter-personal functions (e.g., comment, request) (for reviews see Meindl & Cannella-Malone, 2011; Tasker & Schmidt, 2008). These communicative actions begin early in the first months of life when an infant shares eye-to-eye gaze with a parent and ‘looks where someone else is looking’ (Butterworth & Jarrett, 1991; Scaife & Bruner, 1975). By 12 months, most infants begin to direct the attention of others (using gaze and/or gesture), but the developmental course is quite variable until the consolidation of joint attention skills at around 18 months of age (Carpenter, Nagell, & Tomasello, 1998).

In recent years, the terms ‘joint attention’ and ‘social attention’ have been used interchangeably. This has primarily derived from the work of Mundy et al. (2007) who define joint attention as ‘the capacity for social attention coordination’, including responding to (i.e., following the gaze shift/head turn or pointing gestures of others to locate an object/event of interest) and initiating joint attention (i.e., use of eye contact and gestures to direct the attention of others to an object/event of interest). Mundy and others suggest that early joint attention entrains a form of executive social attention that provides the foundation for social-cognitive and symbolic processes (Mundy, Sullivan, & Mastergeorge, 2009).

Although there is clear rationale for social communication behavior as one component of social attention activity produced by the individual, it is important to acknowledge the limitations of defining social attention exclusively *as* joint attention (or the reverse, defining social attention as joint attention). The dual usage of joint attention, both to describe the behaviors of interest and to describe the function of the behaviors, has been recently articulated (Tasker & Schmidt, 2008). We suggest that considering the functional characterizations of social attention (as behavior, motivation, and attention) offers one way to approach disentangling social attention mechanisms and construct. Indeed, theory suggests that joint attention reflects frontal lobe and executive function processes such as attention regulation and inhibition/disinhibition as well as individual differences in social interest and motivation (Dawson et al., 2002; Mundy et al., 2000; Mundy et al., 2009). Viewing joint attention behavior (e.g., eye gaze, gesture) as an ability or skill that is distinct from, although related to, underlying social motivation and basic attention processes, allows empirical examination of the degree to which these processes reflect a unified construct across the lifespan among typically and atypically developing individuals. We consider these functions next.

Social Attention as Social Motivation

Clinical research uses the term social attention broadly to characterize dysfunction in monitoring and decoding of social cues in a variety of clinical disorders, including individuals with anxiety disorders (Gardner, Pickett, Jefferis, & Knowles, 2005), attention-deficit/hyperactivity disorder (Stroes, Alberts, & Van Der Meere, 2003), schizophrenia (Nestor, Klein, Pomplun, Niznikiewicz, & McCarley, 2010), Williams Syndrome (Riby & Hancock, 2008), Cornelia-Lange Syndrome (Sarimski, 2007) and ASD. Although the clinical literature often references atypical joint attention as social attention (e.g., Kasari, Sigman, & Yirmiya, 1993; Mundy & Sigman, 2006; Noland, Reznick, Stone, Walden, &

Sheridan, 2010), this literature also yields a distinct function and use of the term—as social motivation to engage with others. The atypical manifestation of joint attention (i.e., social attention) among clinical populations is considered evidence of fundamental differences in the degree to which social information is prioritized—as a function of the reward or reinforcement value of the social stimulus for that individual—and this variability in social motivation is considered an index of social attention.

This viewpoint is most clearly illustrated in ASD research, with behavioral hallmarks including persistent deficits in social communication and social interaction alongside restricted, repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). Deficits are manifest as impairments in social reciprocity (e.g., reduced sharing of emotions, failure to initiate/respond to social interactions), nonverbal communication behaviors (e.g., unusual eye contact, deficits in use of gesture), and deficits in developing, maintaining, and understanding relationships (e.g., difficulty adjusting behavior for social context, absence of interest in peers). Important for the present discussion, social attention impairment has long been considered the core behavioral feature of ASD (see Chevallier, Kohls, Troiani, Brodtkin, & Schultz, 2012).

As a result, much of the ASD literature that has used the term social attention has done so in reference to broadband social impairments in ASD without directly operationalizing social attention; the remaining literature has examined social attention more directly with varying degrees of specificity (see Supporting Information). The following examples represent typical measurement of social attention in the ASD literature:

1. duration of looking to people (face, eyes, mouth) while viewing photographs (Birmingham, Cerf, & Adolphs, 2011; Sasson & Touchstone, 2013), movies (Chawarska, Macari, & Shic, 2012; Parish-Morris et al., 2013), or during live interaction (Freeth, Foulsham, & Kingstone, 2013; Hutman, Chela, Gillespie-Lynch, & Sigman, 2012);
2. orienting (e.g., turning head and/or eyes) to people (Laidlaw, Foulsham, Kuhn, & Kingstone, 2011; Maestro et al., 2002, 2005) or human sounds (Dawson, Toth, et al., 2004); change detection across two nearly identical social scenes (New et al., 2010);
3. gaze following/attention cueing (Greene et al., 2011; Riby, Hancock, Jones, & Hanley, 2013);
4. attention shifting between people and objects (Hutman et al.);
5. joint attention behaviors including responding to (e.g., turning eyes and/or head to follow examiner's point and gaze) and initiating (e.g., gaze, alternating gaze, showing, pointing to share attention) coordinated attention with others (e.g., Barbaro & Dissanayake, 2010; Bedford et al., 2014); smiling and vocalizing while interacting with others (e.g., Maestro et al.).

The wide variability in conceptualization and measurement of social attention in ASD is clearly apparent in these examples (note that use of the term has been aligned with all three

functional categories). In each case, the stated (or implicit) assumption is that various indices of attention to people and/or social communication behaviors (joint attention) operate as a proxy for indexing clinically relevant social attention differences in ASD.

Theoretically, deficits in social motivation are thought to underlie the deficits in social attention observed in ASD. Indeed, social motivation has recently been described as ‘a set of psychological dispositions and biological mechanisms biasing the individual to preferentially orient to the social world (social orienting), to seek and take pleasure in social interactions (social reward), and to work to foster and maintain social bonds (social maintaining)’ (Chevallier et al., 2012). This definition underscores the possibility that the motivational, or reward value, of the social environment contributes to other aspects of social attention processes (joint attention, basic visual attention) to allow the emergence of individual, and clinically relevant, differences in social attention activity.

Although theoretical accounts differ as to the specific mechanisms by which social impairments arise within ASD, a common component is the failure to accrue social experiences necessary for real-world functional social communication. One influential theory suggests that social deficits result from early disruptions in social engagement and social attention (including a lack of salience for social stimuli and early preferential orienting), with the downstream effect of disrupting typical brain and behavioral development including social cognitive abilities (see for example Klin, Jones, Schultz, & Volkmar, 2003; Mundy & Neal, 2001). This has been more formally articulated as the social motivation hypothesis, which proposes that autism involves reduced social reward sensitivity and concomitant differences in social attention (e.g., Chevallier et al., 2012; Dawson, Webb, & McPartland, 2005). Research efforts, in turn, have focused on identification of neuropsychological and developmental factors that may reflect social attention (e.g., typical/atypical face processing, emotion recognition, joint attention).

The ASD literature that discusses social attention in terms of social motivation deficits has generally measured joint attention and basic visual attention as indices of social motivation processes (Dawson, Toth, et al., 2004; Dawson, Webb, Carver, Panagiotides, & McPartland, 2004; Kasari, Freeman, & Paparella, 2006; Maestro et al., 2002, 2005, 2006). As a result, the existing literature is limited by the degree to which capacity for joint attention can be differentiated from social motivation (although note that one comparative study has considered social motivation in a mouse model of ASD by measuring social approach and novelty preference toward conspecifics; Karvat & Kimchi, 2013). A related line of research has examined brain correlates of social motivation, primarily among children with ASD (for a recent review see Schaer, Franchini, & Eliez, 2014). Although the overlap with behavioural indices of social motivation has not yet been considered, this literature has demonstrated evidence of individual differences in social motivation; for example, typically developing children may experience face stimuli as more rewarding compared to children with ASD (e.g., Key & Corbett, 2014; Stavropoulos & Carver, 2014).

Social Attention as Basic Visual Attention

Developmental research has long considered early attention preferences and has included faces and face-like stimuli among the various stimuli presented. This work has more recently

been considered through the prism of social attention. For example, infants' early preference for looking at face-like stimuli (e.g., Johnson, Dziurawiec, Ellis, & Morton, 1991) and ability to discriminate direct from averted gaze soon after birth (e.g., Farroni, Csibra, Simion, & Johnson, 2002) have been interpreted in the context of emerging social attention behaviors (e.g., see Perra & Gattis, 2010). The most frequent use of the term social attention in this literature has been in the context of gaze following. Standard gaze following paradigms have involved an attention-shifting cue such as an adult head turn and/or gaze shift, with accuracy in following the cue then interpreted as evidence of social attention (for a review see Langton, Watt, & Bruce, 2000). Importantly, the implication here is that attention processes in the context of social information are unique and can be differentiated from attention to non-social sources of information. Whether this is actually the case has not been systematically examined.

The influence of both social and non-social information has been examined primarily in the literature on reflexive attention cueing (i.e., reflexive gaze following). Reflexive shifting accuracy has been examined under varying conditions of cueing accuracy in the presence of another person's gaze shift/head turn (Langton, 2000; Langton & Bruce, 1999; Langton, O'Donnell, Riby, & Ballantyne, 2006; Ristic & Kingstone, 2005), gesture, or body orientation (Langton & Bruce, 2000; Pomianowska, Germeys, Verfaillie, & Newell, 2011). Within this literature, it has been well established that both social (i.e., involving people) and non-social cues (e.g., arrows, the words 'left' and 'right', and even eyes on a glove looking left and right) shift attention for adults and children with similar activation of brain mechanisms. For example, Crostella, Carducci, and Aglioti (2009) directly compared social (others' gaze or hand orientation) and non-biological (an arrow) directional cues for reflexive gaze following. In another example, Wu and Kirkham (2010) compared infant attention shifting to social cues (i.e., movie of a smiling female saying 'Hi baby, look at this!' while looking toward one corner of screen containing an animal animation) and non-social cues (i.e., colored box appearing around the corner of the screen containing an animal animation).

Importantly, the questionable applicability of standard lab-based studies of attention to conspecifics in real-world contexts has been acknowledged (Birmingham & Kingstone, 2009; Kingstone, 2009; Risko et al., 2012). The majority of behavioral and neuroimaging studies to date have examined social attention in the lab by presenting faces in isolation and may have overestimated the degree to which we look at others' eyes and the degree to which we look where others are looking (Kingstone). Attempts to take into consideration the limitations of lab-based measures of social attention have involved more ecologically valid contexts, such as presenting adults with free-viewing paradigms with naturalistic real-world scenes (e.g., Birmingham, Bischof, & Kingstone, 2008; Laidlaw, Risko, & Kingstone, 2012) and live social interaction opportunities (Freeth et al., 2013; Laidlaw et al., 2011), wherein social orienting or looking at others is the outcome of interest. In these studies, social attention has been defined as 'how one's attention is affected by the presence of other individuals' (Birmingham et al.); 'how spatial attention is allocated to biologically relevant stimuli' (Laidlaw et al.); and 'the manner in which we attend to other living beings, in particular conspecifics' (Freeth et al.). This group of studies highlights the need to for an empirical approach to determine the equivalence of social stimuli presented across studies

(e.g., simple, static representations of social relevant stimuli compared to real-world, live social interaction; see also Risko et al.), as well as systematic examination of the role of context and the valence of the social signal itself.

A limited number of studies have examined other components of basic visual attention (e.g., visual preference; decrement in looking) in the context of social events. Those that have done so have generally included only social stimuli (e.g., Wellman, Lopez-Duran, LaBounty, & Hamilton, 2008; Wellman, Phillips, Dunphy-Lelii, & LaLonde, 2004), limiting direct comparison of attention processes as a function of context. Some suggestion of differences in allocation of attention to social stimuli can be gleaned from literature on perceptual biases for threat-related stimuli, although comparisons are typically between degree of threat (e.g., happy/neutral faces, flowers vs. angry/fearful faces, snakes) rather than comparing social vs. non-social stimuli (LoBue, 2014; LoBue & Perez-Edgar, 2014).

In recent years, social neuroscience has produced a growing interest in characterizing neural networks that are active in the context of social cues, guided by the premise that socially relevant stimuli would engage the social brain differently than other kinds of stimuli. This literature views humans as uniquely social mammals and seeks to identify brain areas and neural circuits that are preferentially active while negotiating aspects of the social environment. Techniques utilized include eye gaze tracking, functional neuroimaging of the brain using socially salient visual stimuli (faces with different emotional expressions or gaze direction), electroencephalographic measurements that detect very rapid shifts in the pattern of electrical activity in the brain, and pharmacological probes that impact social perception and behavior. This literature has compared neural processing of faces vs. objects (for reviews see Dien, 2009; Hoehl & Peykarjou, 2012), but has not generally examined patterns of association between both brain and behavioral measures of social attention; one notable exception has documented relations between neural networks and language development processes in infants and young children (for a recent overview see Kuhl, 2014).

Where To From Here?

The growing interest in social attention in the last decade is not surprising, given the potential impact of this research for a broad range of developmental outcomes, including language, social communication, social-emotional development, and various clinical disorders. To advance this behavioral neuroscience and developmental neurocognitive literature, the conceptual and operational definition of social attention must be clearly articulated. We have offered a framework that categorizes existing literature based on the functions of social attention: as *social attention behavior* directed toward coordinating interaction with others (or the use of nonverbal communication/joint attention behaviors), as *social motivation* to engage with others (or the reward value derived from interaction), and as *basic attention* processes in the context of social streams of information (or the capacity to visually attend to conspecifics). It is clear that the term social attention is called into service to reference a wide range of activities that emerge in the presence of conspecifics.

There is potential for conceptual overlap, to the extent that these activities reflect components of social interaction processes; there is also potential divergence, given that

these activities reflect distinct skills and developmental pathways. Generally speaking, the handling of this term within the literature implies that social attention is an *independent* construct that can be differentiated from other domains of activity and that the functions of social attention are *inter-related* indices that reflect a unitary construct. To advance social attention as a construct, we ask (1) is social attention truly a construct in its own right, separate from other forms of activity in these domains and (2) whether all measures of social attention share a common coherence or thread.

Social Attention as an Independent Construct

One of the central questions within social neuroscience is the extent to which general cognitive processes explain social developmental outcomes, or whether specific processes that are unique to social interaction account for these skills. This question is particularly relevant for articulating the construct of social attention. As described above, in most cases definitions of social attention references some aspect of the social milieu, with the implicit or explicit judgment that this is distinct from other (non-social) aspects of the environment. Whether social attention in any of its functions and forms can be differentiated from other non-social domains of activity has been rarely examined in a direct way.

One possibility would be that early in development, attention regulation capacity in the context of non-social and social events is isomorphic, but begins to diverge during the 8–12 month period, concurrent with the emergence of endogenous attention and executive function (resulting from brain maturation) along with cortical specialization for social stimuli, and ultimately becomes independent through the expression of social interaction behaviors (e.g., joint attention, nonverbal communication). In comparison to non-social sources of information (i.e., objects and events that do not include people), other social agents provide access to dynamic cues in an interactive context, which may uniquely influence the development of basic attention skills (i.e., attentional state, orienting, endogenous attention) (Colombo & Salley, 2015). Indeed, recent work has revealed more pronounced differences in electroencephalogram (EEG) activity for social vs. non-social stimuli for 12- compared to 6-month-old infants, suggesting that changes in cortical selectivity to social information support underlying specialization for social stimuli in the second half of the first year of life (Jones, Venema, Lowy, Earl, & Webb, 2015). This view is also supported by behavioral and neurobiological studies indicating social experiences during infancy have an important and lasting impact on social-perceptual processing, and may be important for the development of brain networks that are involved in processing social stimuli and support language development (for a discussion see Mills & Conboy, 2009; Pascalis, Kelly, & Schwarzer, 2009). An early preference for, or bias toward, social information may also play a role in shaping the transaction between basic attention and emerging joint attention behavior. Evidence suggests that early perceptual biases for threatening stimuli may operate as a catalyst for the emergence of fears, by focusing attention selectively to threatening information (LoBue, 2013). The social context may impart unique information that influences the development of (1) basic attention skills (i.e., attentional state, attention to object features, and spatial orienting) in ways that are accelerated and sophisticated, (2) motivation or reward value of the contingent social

engagement experience, and (3) ultimately, the emergence of preverbal (and later verbal) communication behaviors.

Social Attention as a Unitary Construct

It is not by accident that social attention has been characterized in each of the functional categories discussed here. However, these social attention functions may or may not reflect a unitary construct, with the same underlying processes and mechanisms. For example, social attention behavior, social motivation, and basic visual attention to social information may be correlated (or separable) processes as a product of various factors, including typical/atypical development, age, experiences, and so on.

Although theory suggests connections between joint attention and attention regulation (e.g., Mundy et al., 2009; Vaughan Van Hecke & Mundy, 2007), and studies have associated neural activity with joint attention behaviors (Emery, 2000; Henderson, Yoder, Yale, & McDuffie, 2002; Mundy et al., 2000; Striano, Reid, & Hoehl, 2006), to date, no direct empirical examination of the link between basic visual attention regulation and joint attention behavior has occurred. It is unknown whether joint attention reflects the development of general aspects of attention, or alternatively, whether it reflects socially specific attention (i.e., attention regulation in the context of other social agents; Mundy & Newell, 2007). Furthermore, although the social motivation hypothesis proposes associations between early visual attention, the reward value of social information, and later joint attention, these links have not been systematically addressed. To examine this question will require systematic comparison of each functional category under both social and non-social contexts across development.

If the social context does indeed support the development of social attention functions in unique ways, it may be that social attention functions discussed here are initially relatively distinct, but emerge as a unitary process during the course of typical developmental pathways. For example, the typically developing infant experiences in tandem the emerging *preference for* and *visual experience of* viewing social information, which allows the infant to gain critical endogenous attention regulation skills, that in turn support joint attention behavior. The consolidation of joint attention behaviors at around 18 months of age is one possible point at which social attention activities may reflect a unitary construct. Although the typical developmental pathway may result in the convergence of social attention activity, atypical pathways may be characterized by increased differentiation (see Figure 1). For some atypically developing populations, the early development of social visual attention, social motivation, and social behavior (joint attention) become increasingly disassociated to the degree that these processes may not reflect a unitary construct. This may be particularly relevant for ASD, as differences in social attention processes may derive as a function of context, task particulars, and individual factors. For example, an individual with ASD may have the capacity to engage in social attention behavior (i.e., possess the skill to engage in joint attention), but present with deficits in social motivation, which may or may not correspond to differences in basic attention regulation in the context of social streams of information. This would offer an explanation for aspects of basic attention processes that may be relatively spared among individuals with ASD (Guillon, Hadjikhani, Baduel, &

Roge, 2014), while other aspects of social attention (social motivation and joint attention) are dysfunctional. In this view, the degree of atypicality within each of these domains of social attention function would directly impact the extent to which these processes would reflect a unitary construct of social attention.

Next Steps and Implications

Consideration of the construct of social attention raises a number of questions and implications relevant for developmental and clinical science. The demonstration that social attention is dissociable from other more basic forms of attention carries with it the potential implication of different channels of information processing. Although evidence for such dissociability would not necessarily imply the existence of some native specialized module for the processing of social information or for the processing of information acquired within social contexts, it seems entirely plausible that social and non-social attention may be parcellated developmentally, much like other types of expertise or automaticity that have been described in the developmental and cognitive literatures. Indeed, previous researchers have sought to identify multiple dissociable processes for memory (Baddeley & Hitch, 1974) and for other forms of attentional processes (Navon & Miller, 2001; Uncapher, Hutchinson, & Wagner, 2011). To identify whether these social attention functions—social visual attention, social motivation, social behavior—are unique (or convergent) developmental processes, this question should be directly examined by including multiple measures of each functional aspect.

Aside from our understanding of the underlying structure of cognition and cognitive development, the existence of a dissociable mode of social attention would, in fact, have a number of important implications for our interpretation of research on attentional processes and their development. The first of these is that existing research characterizing attention to largely non-social targets may not represent those same attention processes in the context of social information. Although including social and non-social stimuli in every study of attention and its development seems costly and perhaps overreaching for every study irrespective of its actual purpose or intent, evidence supporting a dissociable form of social attention would dictate that such tests would be critical to any claim of generalizability of the process under study.

Other primary implications bear on our conceptualization and approaches to treatment of intellectual and developmental disabilities that might be characterized by atypical social development or function. Both the notion that attention might be parsed into separable social and non-social forms and that all indices of social attention may not be equal have important implications for the identification of atypical developmental pathways. The use of both social and non-social targets in a multifunction approach would be essential for efforts aimed at developing potential biobehavioral markers for early identification of such individuals. Systematic longitudinal studies using these methods for both typical, atypical, and at-risk populations would also be necessary to identify the developmental course—that is, whether and when parcellation of social and non-social attention is present across development and whether and when social attention functions represent unitary or nonunitary processes. The degree of relationship among social attention functions and

processes would in turn have direct implications for closely related developmental outcomes (e.g., language, social communication, social-emotional development, ASD, and other clinical disorders). Other important potential implications relate to the development of intervention and treatment programs for such disorders. Research that directly considers whether certain functions may be relatively spared or more compromised within some individuals or disorders would have the potential to allow precise selection of optimal targets for treatment.

Consideration of other processes that may be relevant to, or a component of, the construct of social attention, will also be important. For example, it is likely that emotion regulation and temperament processes may play an important role in shaping the developmental emergence and expression of social attention across the lifespan. Indeed, Todd, Cunningham, Anderson, & Thompson (2012) have argued that attention processes are directly biased by the relative emotional salience of stimuli in a way that preferentially tunes subsequent attention regulation, while other research has demonstrated associations between individual differences in temperament and the expression of joint attention and social engagement behaviors (Salley & Dixon, 2007; Salley, Miller, & Bell, 2013).

Conclusions

With many of the fundamental questions about social attention yet unanswered, we offer the following conclusions and caveats. Social attention has been considered as a conceptual construct that captures a set of functional demands including attention to the social world (social visual attention), the degree to which attending to and/or engaging with the social world yields reward/reinforcing value (social motivation), and the behaviors produced to allow and maintain interaction with the social world through joint attention (social behavior). The extent to which social attention is (or becomes) a unitary construct over the course of development remains an outstanding question to be addressed, as does the question of whether social and non-social attention processes are dissociable. We have provided here a framework for conceptualizing the current functional use of social attention within and across developmental science, and we view this as an important tipping point for future theoretical discussion and empirical examination. Our aim here has not been to argue that the term social attention must be conceptualized as social visual attention, social motivation, and social behavior, but rather, that direct examination of these functions will advance theoretical and empirical work pertaining to the construct of social attention. For example, differentiating between an individuals' attention to others' use of nonverbal communication behaviors (i.e., joint attention) and attention to others in the absence of their use of cueing behaviors (i.e., social visual attention) may be theoretically meaningful, and would certainly bear on the measurement and operationalization of social attention.

The path to answering these questions will involve clarifying associations between social attention functions and other related developmental processes. Future research efforts should consider carefully how terminology can best be refined to avoid theoretical confusion. We have asked here whether current use of the term social attention is an *independent construct* (whether any forms of social attention can be differentiated from the same domain of activity in a non-social context) and if it reflects a *unitary process* (whether all forms of

social attention are equal)—the answers to both of these questions are critical next steps to establish social attention as a useful construct.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Preparation of this manuscript was supported by grant HD 075886 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) to Brenda Salley and by the Kansas Intellectual and Developmental Disabilities Research Center HD 002528. The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of the NICHD or the National Institutes of Health.

References

- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th. Washington: Author; 2013.
- Baddeley, AD.; Hitch, GJ. Working memory. In: Bower, GA., editor. The psychology of learning and motivation: Advances in research and theory. Vol. 8. New York: Academic Press; 1974. p. 47-89.
- Barbaro J, Dissanayake C. Prospective identification of autism spectrum disorders in infancy and toddlerhood using developmental surveillance: The social attention and communication study. *Journal of Developmental and Behavioral Pediatrics*. 2010; 31:376–385. [PubMed: 20495475]
- Bates E, Camaioni L, Volterra V. The acquisition of performatives prior to speech. *Merrill-Palmer Quarterly*. 1975; 21:205–226.
- Bedford R, Pickles A, Gliga T, Elsabbagh M, Charman T, Johnson MH. Additive effects of social and non-social attention during infancy relate to later autism spectrum disorder. *Developmental Science*. 2014; 17:612–620. [PubMed: 25089324]
- Birmingham E, Bischof WF, Kingstone A. Social attention and real-world scenes: The roles of action, competition and social content. *Quarterly Journal of Experimental Psychology*. 2008; 61:986–998.
- Birmingham E, Cerf M, Adolphs R. Comparing social attention in autism and amygdala lesions: Effects of stimulus and task condition. *Social Neuroscience*. 2011; 6:420–435. [PubMed: 21943103]
- Birmingham E, Kingstone A. Human social attention: A new look at past, present, and future investigations. *Annals of the New York Academy of Sciences*. 2009; 1156:118–140. [PubMed: 19338506]
- Bruner J. From communication to language: A psychological perspective. *Cognition*. 1976; 3:255–287.
- Butterworth G, Jarrett N. What minds have in common is space: Spatial mechanisms serving joint visual attention in infancy. *British Journal of Developmental Psychology*. 1991; 9:55–72.
- Carpenter M, Nagell K, Tomasello M. Social cognition, joint attention and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*. 1998; 63:1–143.
- Chawarska K, Macari S, Shic F. Context modulates attention to social scenes in toddlers with autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*. 2012; 53:903–913.
- Chevallier C, Kohls G, Troiani V, Brodtkin ES, Schultz RT. The social motivation theory of autism. *Trends in Cognitive Sciences*. 2012; 16:231–239. [PubMed: 22425667]
- Colombo, J.; Salley, B. Biopsychosocial perspectives on the development of attention in infancy. In: Calkins, SD., editor. *Handbook of Infant Biopsychosocial Development*. New York: Guilford Press; 2015. p. 71-96.
- Crostella F, Carducci F, Aglioti SM. Reflexive social attention is mapped according to effector-specific reference systems. *Experimental Brain Research*. 2009; 197:143–151. [PubMed: 19565230]

- Dawson G, Munson J, Estes A, Osterling J, McPartland J, Toth K, et al. Neurocognitive function and joint attention ability in young children with autism spectrum disorder versus developmental delay. *Child Development*. 2002; 73:345–358. [PubMed: 11949896]
- Dawson G, Toth K, Abbott R, Osterling J, Munson J, Estes A, et al. Early social attention impairments in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology*. 2004; 40:271–283. [PubMed: 14979766]
- Dawson G, Webb SJ, Carver L, Panagiotides H, McPartland J. Young children with autism show atypical brain responses to fearful versus neutral facial expressions of emotion. *Developmental Science*. 2004; 7:340–359. [PubMed: 15595374]
- Dawson G, Webb SJ, McPartland J. Understanding the nature of face processing impairment in autism: Insights from behavioral and electrophysiological studies. *Developmental Neuropsychology*. 2005; 27:403–424. [PubMed: 15843104]
- Dien J. A tale of two recognition systems: Implications of the fusiform face area and the visual word form area for lateralized object recognition models. *Neuropsychologia*. 2009; 47:1–16. [PubMed: 18805434]
- Emery N. The eyes have it: The neuroethology, function, and evolution of social gaze. *Neuroscience and Behavioral Reviews*. 2000; 24:581–604.
- Farroni T, Csibra G, Simion F, Johnson MH. Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences of the United States of America*. 2002; 99:9602–9605. [PubMed: 12082186]
- Freeth M, Foulsham T, Kingstone A. What affects social attention? Social presence, eye contact and autistic traits. *PloS One*. 2013; 8:e53286. [PubMed: 23326407]
- Gardner WL, Pickett CL, Jefferis V, Knowles M. On the outside looking in: Loneliness and social monitoring. *Personality and Social Psychology Bulletin*. 2005; 31:1549–1560. [PubMed: 16207773]
- Greene DJ, Colich N, Iacoboni M, Zaidel E, Bookheimer SY, Dapretto M. Atypical neural networks for social orienting in autism spectrum disorders. *Neuro-Image*. 2011; 56:354–362. [PubMed: 21334443]
- Guillon Q, Hadjikhani N, Baduel S, Roge B. Visual social attention in autism spectrum disorder: Insights from eye tracking studies. *Neuroscience Biobehavioral Review*. 2014; 42:279–297.
- Henderson LM, Yoder PJ, Yale ME, McDuffie A. Getting the point: Electrophysiological correlates of protodeclarative pointing. *International Journal of Developmental Neuroscience*. 2002; 20:449–458. [PubMed: 12175886]
- Hoehl S, Peykarjou S. The early development of face processing-what makes faces special? *Neurosci Bull*. 2012; 28:765–788. [PubMed: 23132679]
- Hutman T, Chela MK, Gillespie-Lynch K, Sigman M. Selective visual attention at twelve months: Signs of autism in early social interactions. *Journal of Autism and Developmental Disorders*. 2012; 42:487–498. [PubMed: 21519953]
- Johnson MH, Dziurawiec S, Ellis H, Morton J. Newborns' preferential tracking of face-like stimuli and its subsequent decline. *Cognition*. 1991; 40:1–19. [PubMed: 1786670]
- Jones EJ, Venema K, Lowy R, Earl RK, Webb SJ. Developmental changes in infant brain activity during naturalistic social experiences. *Developmental Psychobiology*. 2015; 57:842–853. [PubMed: 26219834]
- Karvat G, Kimchi T. Acetylcholine elevation relieves cognitive rigidity and social deficiency in a mouse model of autism. *Neuropsychopharmacology*. 2013; 39:831–840. [PubMed: 24096295]
- Kasari C, Freeman S, Paparella T. Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *Journal of Child Psychology and Psychiatry*. 2006; 47:611–620. [PubMed: 16712638]
- Kasari C, Sigman M, Yirmiya N. Focused and social attention of autistic children in interactions with familiar and unfamiliar adults: A comparison of autistic, mentally retarded, and normal children. *Development and Psychopathology*. 1993; 5:403–414.
- Key AP, Corbett BA. ERP responses to face repetition during passive viewing: A nonverbal measure of social motivation in children with autism and typical development. *Developmental Neuropsychology*. 2014; 39:474–495. [PubMed: 25144259]

- Kingstone A. Taking a real look at social attention. *Current Opinions in Neurobiology*. 2009; 19:52–56.
- Klin, A.; Jones, W.; Schultz, R.; Volkmar, F. The enactive mind, or from actions to cognition: Lessons from autism. In: Frith, U.; Hill, EL., editors. *Autism: Mind and brain*. New York: Oxford University Press; 2003.
- Kuhl PK. Early Language Learning and the Social Brain. *Cold Spring Harbor Symposium on Quantitative Biology*. 2014; 79:211–220.
- Laidlaw KE, Foulsham T, Kuhn G, Kingstone A. Potential social interactions are important to social attention. *Proceedings of the National Academy of Sciences of the United States of America*. 2011; 108:5548–5553. [PubMed: 21436052]
- Laidlaw KE, Risko EF, Kingstone A. A new look at social attention: Orienting to the eyes is not (entirely) under volitional control. *Journal of Experimental Psychology. Human Perception and Performance*. 2012; 38:1132–1143. [PubMed: 22686696]
- Langton SRH. The mutual influence of gaze and head orientation in the analysis of social attention direction. *The Quarterly Journal of Experimental Psychology*. 2000; 53:825–845. [PubMed: 10994231]
- Langton SRH, Bruce V. Reflexive visual orienting in response to the social attention of others. *Visual Cognition*. 1999; 6:541–567.
- Langton SRH, Bruce V. You must see the point: Automatic processing of cues to the direction of social attention. *Journal of Experimental Psychology. Human Perception and Performance*. 2000; 26:747–757. [PubMed: 10811173]
- Langton SRH, O'Donnell C, Riby DM, Ballantyne CJ. Gaze cues influence the allocation of attention in natural scene viewing. *Quarterly Journal of Experimental Psychology*. 2006; 59:2056–2064.
- Langton SRH, Watt RJ, Bruce V. Do the eyes have it? Cues to the direction of social attention. *Trends in Cognitive Sciences*. 2000; 4:50–59. [PubMed: 10652522]
- LoBue V. What are we so afraid of? How early attention shapes our most common fears. *Child Development Perspectives*. 2013; 7:38–42.
- LoBue V. Measuring attentional biases for threat in children and adults. *Journal of Visual Experiments*. 2014; 92:e52190.
- LoBue V, Perez-Edgar K. Sensitivity to social and non-social threats in temperamentally shy children at-risk for anxiety. *Developmental Science*. 2014; 17:239–247. [PubMed: 24283271]
- Maestro S, Muratori F, Cavallaro MC, Pecini C, Cesari A, Paziente A, et al. How young children treat objects and people: An empirical study of the first year of life in autism. *Child Psychiatry and Human Development*. 2005; 35:383–396. [PubMed: 15886871]
- Maestro S, Muratori F, Cavallaro MC, Pei F, Stern D, Golse B, et al. Attentional skills during the first 6 months of age in autism spectrum disorder. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2002; 41:1239–1245. [PubMed: 12364846]
- Maestro S, Muratori F, Cesari A, Pecini C, Apicella F, Stern D. A view to regressive autism through home movies. Is early development really normal? *Acta Psychiatria Scandanavia*. 2006; 113:68–72.
- Meindl JN, Cannella-Malone HI. Initiating and responding to joint attention bids in children with autism: A review of the literature. *Research in Developmental Disabilities*. 2011; 32:1441–1454. [PubMed: 21450441]
- Mills, D.; Conboy, BT. Early communicative development and the social brain. In: de Haan, M.; Gunnar, MR., editors. *Handbook of Developmental Social Neuroscience*. New York: Guilford; 2009. p. 175–206.
- Mundy P, Block J, Delgado C, Pomares Y, Van Hecke AV, Parlade MV. Individual differences and the development of joint attention in infancy. *Child Development*. 2007; 78:938–954. [PubMed: 17517014]
- Mundy P, Card J, Fox N. EEG correlates of the development of infant joint attention skills. *Developmental Psychobiology*. 2000; 36:325–338. [PubMed: 10797253]
- Mundy P, Neal AR. Neural plasticity, joint attention, and a transactional social-orienting model of autism. *International Review of Research in Mental Retardation*. 2001; 23:139–168.

- Mundy P, Newell L. Attention, joint attention, and social cognition. *Current Directions in Psychological Science*. 2007; 16:269–274. [PubMed: 19343102]
- Mundy, P.; Sigman, M. Joint attention, social competence, and developmental psychopathology. In: Mundy, P.; Sigman, M., editors. *Developmental Psychopathology, Vol 1: Theory and Method*. 2nd. Hoboken, NJ: Wiley; 2006. p. 293-332.
- Mundy P, Sullivan L, Mastergeorge AM. A parallel and distributed-processing model of joint attention, social cognition and autism. *Autism Research*. 2009; 2:2–21. [PubMed: 19358304]
- Navon D, Miller J. Queuing or sharing? A critical evaluation of the single-bottleneck notion. *Cognitive Psychology*. 2001; 44:193–251.
- Nestor PG, Klein K, Pomplun M, Niznikiewicz M, McCarley RW. Gaze cueing of attention in schizophrenia: Individual differences in neuropsychological functioning and symptoms. *Journal of Clinical and Experimental Neuropsychology*. 2010; 32:281–288. [PubMed: 19544134]
- New JJ, Schultz RT, Wolf J, Niehaus JL, Klin A, German TC, et al. The scope of social attention deficits in autism: Prioritized orienting to people and animals in static natural scenes. *Neuropsychologia*. 2010; 48:51–59. [PubMed: 19686766]
- Noland JS, Reznick SJ, Stone WL, Walden T, Sheridan EH. Better working memory for non-social targets in infant siblings of children with Autism Spectrum Disorder. *Developmental Science*. 2010; 13:244–251. [PubMed: 20121880]
- Parish-Morris J, Chevallier C, Tonge N, Letzen J, Pandey J, Schultz RT. Visual attention to dynamic faces and objects is linked to face processing skills: A combined study of children with autism and controls. *Frontiers in Psychology*. 2013; 4:185.
- Pascalis, O.; Kelly, DJ.; Schwarzer, G. Neural bases of the development of face processing. In: de Haan, M.; Gunnar, MR., editors. *Handbook of Developmental Social Neuroscience*. New York: Guilford; 2009. p. 63-86.
- Perra O, Gattis M. The control of social attention from 1 to 4 months. *British Journal of Developmental Psychology*. 2010; 28:891–908. [PubMed: 21121473]
- Pineda JA, Sebestyen G, Nava C. Face recognition as a function of social attention in non-human primates: An ERP study. *Brain Research*. 1994; 2:1–12. [PubMed: 7812173]
- Pomianowska I, Germeys F, Verfaillie K, Newell FN. The role of social cues in the deployment of spatial attention: Head-body relationships automatically activate directional spatial codes in a Simon task. *Frontiers in integrative neuroscience*. 2011; 6:4. [PubMed: 22347172]
- Reynolds NJ, Risley TR. The role of social and material reinforcers in increasing talking of a disadvantaged preschool child. *Journal of Applied Behavioral Analysis*. 1968; 1:253–262.
- Riby DM, Hancock PJ. Viewing it differently: Social scene perception in Williams syndrome and autism. *Neuropsychologia*. 2008; 46:2855–2860. [PubMed: 18561959]
- Riby DM, Hancock PJ, Jones N, Hanley M. Spontaneous and cued gazefollowing in autism and Williams syndrome. *Journal of Neurodevelopmental Disorders*. 2013; 5:13. [PubMed: 23663405]
- Risko EF, Laidlaw K, Freeth M, Foulsham T, Kingstone A. Social attention with real versus reel stimuli: Toward an empirical approach to concerns about ecological validity. *Frontiers in Human Neuroscience*. 2012; 6:143. [PubMed: 22654747]
- Ristic J, Kingstone A. Taking control of reflexive social attention. *Cognition*. 2005; 94:B55–B65. [PubMed: 15617667]
- Salley B, Dixon WE Jr. Temperamental and joint attentional predictors of language development. *Merrill-Palmer Quarterly*. 2007; 53:131–154. [PubMed: 18080005]
- Salley B, Miller A, Bell MA. Associations between Temperament and Social Responsiveness in Young Children. *Infant and Child Development*. 2013; 22:270–288. [PubMed: 24068881]
- Sarimski K. Infant attentional behaviours as prognostic indicators in Cornelia-de-Lange syndrome. *Journal of Intellectual Disability Research*. 2007; 51:697–701. [PubMed: 17845238]
- Sasson NJ, Touchstone EW. Visual attention to competing social and object images by preschool children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*. 2013; 44:584–592.
- Scaife M, Bruner JS. The capacity for joint visual attention in the infant. *Nature*. 1975; 253:264–265. [PubMed: 1113841]

- Schaer M, Franchini M, Eliez S. Latest findings in autism research. *Swiss Archives of Neurology and Psychiatry*. 2014; 165:277–289.
- Stavropoulos KK, Carver LJ. Reward anticipation and processing of social versus nonsocial stimuli in children with and without autism spectrum disorders. *Journal of Child Psychology and Psychiatry*. 2014; 55:1398–1408. [PubMed: 24890037]
- Striano T, Reid VM, Hoehl S. Neural mechanisms of joint attention in infancy. *The European Journal of Neuroscience*. 2006; 23:2819–2823. [PubMed: 16817886]
- Stroes A, Alberts E, Van Der Meere JJ. Boys with ADHD in social interaction with a nonfamiliar adult: An observational study. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2003; 42:295–302. [PubMed: 12595782]
- Tasker SL, Schmidt LA. The “dual usage problem” in the explanations of “joint attention” and children’s socioemotional development: A reconceptualization. *Developmental Review*. 2008; 28:263–288.
- Todd RM, Cunningham WA, Anderson AK, Thompson E. Affect-biased attention as emotion regulation. *Trends in cognitive sciences*. 2012; 16:365–372. [PubMed: 22717469]
- Uncapher MR, Hutchinson JB, Wagner AD. Dissociable effects of topdown and bottom-up attention during episodic encoding. *Journal of Neuroscience*. 2011; 31:12613–12628. [PubMed: 21880922]
- Vaughan Van Hecke, A.; Mundy, P. Neural systems and the development of gaze-following and related joint attention skills. In: Flom, R.; Lee, K.; Muir, D., editors. *Gaze-following: It’s development and significance*. New Jersey: Erlbaum; 2007.
- Wellman HM, Lopez-Duran S, LaBounty J, Hamilton B. Infant attention to intentional action predicts preschool theory of mind. *Developmental Psychology*. 2008; 44:618–623. [PubMed: 18331149]
- Wellman HM, Phillips AT, Dunphy-Lelii S, LaLonde N. Infant social attention predicts preschool social cognition. *Developmental Science*. 2004; 7:283–288. [PubMed: 15595369]
- Wu R, Kirkham NZ. No two cues are alike: Depth of learning during infancy is dependent on what orients attention. *Journal of Experimental Child Psychology*. 2010; 107:118–136. [PubMed: 20627258]

Figure 1.
Possible Pathway for Typical and Atypical Social Attention Processes.