Developmental Psychology: How social context influences infants' attention.

A recent study shows that changes in the focus of a social partner's attention associate, on a second-by-second scale, with changes in how much attention infants pay to objects.

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Ever since William James claimed that 'everybody knows what attention is' [1], the majority of researchers have followed him in conceptualising attention as an internal property of individual minds, studied in isolation. Conventionally, we distinguish between 'top-down' factors, which are properties of the individual who is attending, and 'bottom-up' factors, which are properties of the stimulus being attended to. But this simple, two-way relationship between the person *attending* and the object being *attended to* is as far as we go.

Although this two-way model describes *some* of our attention (such as when reading a book, alone), in fact, far more of our attention, particularly during early life, occurs in social contexts (such as children paying attention in class, or a child learning early language, in social settings). Here, in addition to properties that

are intrinsic to me, and extrinsic properties of the object being attended to, there are other, fluid properties of the social context in which the individual's attention is being measured.

A recent study by Yu and Smith [2] explores how social context influences attention (see Figure 1). They used head-mounted eye-tracking to record naturalistic, free-flowing interactions between parents and infants. They found that when the social parent jointly attended to same object to which the infant was attending, infants attended to that object for longer than in cases where the parent was attending to a different object. Their findings have implications for understanding both typical and atypical development, and for future intervention research.

Why study attention in naturalistic contexts?

Linda Smith's seminal work emphasises the importance of embodied approaches to cognition [3]. Rather than conceptualising of cognition as internal operations on abstract mental constructs, she emphasises how sensory constructs are generated 'on the fly', and are inseparable from sensory-motor processes [4].

Across a number of recent and highly influential studies Linda Smith, together with Chen Yu, has studied how attention and learning operate in naturalistic contexts [5,6]. Parents and children typically sit opposite each other at a table and engage in free-flowing, naturalistic interactions. Both partners wear head-mounted eyetrackers and microphones. In some studies, parents try to teach

their child labels for novel objects, and the child's retention is tested afterwards [6]. In others, no instructions at all are given, other than a request to 'play naturally'. Previous research using these paradigms has investigated, for example, how the statistical properties of infants' naturally occurring visual environment differs from an adult's, and how this may influence the early development of visual processing [5]. They have also shown how signal-to-noise ratios (the availability of clean, and uncluttered visual and auditory information) can influence how effectively children learn in naturalistic settings [6].

In the present study they examined how the presence of joint attention – whether parents are attending to the same object as their child, or a different one – relates to how long children sustain their attention to an object. Across a pool of naturalistic, 'shared play' data they compared instances when parents and children were attending to the same object with instances when they were attending to different objects. They found that when a parent attended to the same object as the child, the child looked at that object for longer. Across secondary analyses they argued that these differences were not attributable to any properties of the child's gaze *per se* – rather that the parent's gaze directly extends the child's gaze duration. For example, they showed that joint attention extends the infant's attention both during *and after* the joint attention episode - so that the infant continues to focus on the object even after the adult has shifted attention elsewhere.

The power of naturalistic studies is that they show us what happens in the complex real world; their limitations are that the complex threads of causality

are often hard to disentangle. And so, of course, there are several *caveats* to this work. First, it is possible that, while the parents were looking at the same object as the infant, they may have to moved the object, or talked more. It may be that these 'low-level' cues had the effect of increasing the child's attention to the object, by making it more exogenously salient in a 'bottom-up' sense, in a way that is already well studied [7]. Second, look durations *per se* are still a relatively crude measure: for example, research with younger infants has shown that *shorter* looks predicts better language and IQ performance during childhood [8]. Future research should also investigate, for example, whether joint attention also means that a child is more likely to learn information that is taught to them while they are looking at the object than otherwise [6].

Third, it may be possible that naturally occurring slow fluctuations in the child's internal arousal and attention state may have contributed to some of their results [9]. And, finally, it remains to be seen whether the infant's attention drives the adults – just as the adult's attention drives the infants [10,11]. More sophisticated time-series analyses, such as auto-regressive models, would help us to understand these questions in more detail [12]. Nevertheless these findings are provocative, and open a number of directions for future research.

<u>How is our understanding of attention influenced by understanding the social context of attention?</u>

Yu and Smith's findings may be best understood as an interaction effect: the effect of social cues on an individual's attention is mediated by other factors. For

example, ongoing fluctuations in other endogenous factors, such as arousal, may interact with the effect of social cues on attention: when I am in a state of temporarily elevated arousal, social cues may have a stronger effect on my attention than when I am in a state of low arousal [13]. Similarly, research suggests that computerised attentional control training also increases young childrens' sustained attention [14]. It remains to be seen, however, whether strengthening a child's voluntary attention control would increase, or decrease, the degree to which social cues influence that child's attention. My own interest in the object, and in the social partner, will both also affect how much the social partner influences my own attention patterns. Social factors are one factor amongst many that influence our naturalistic attention patterns.

In future, these findings may help us to understand atypical development, and the mechanisms by which unresponsive parent-child interactions (such as reduced maternal sensitivity in post-natal depression) might influence a child's developing attentional capacities [15]. They may also suggest new directions for intervention research – by investigating how changing the social contexts of shared parent-child play can influence a child's endogenous attention capacities [16]. Finally, they open new avenues for neuroimaging. They suggest that instead of conceptualising attention as a property of individual brains, to be studied in isolation, we should instead investigate how human brains show co-varying patterns of change with each other, across learning contexts [17].

In view of recent concerns about the replicability of findings in psychology [18], an increasing trend is towards standardisation, and controlling all experimental

variables. One danger that should be borne in mind is that of throwing ‘the baby out with the bathwater’: in attempting to standardise our experiment we may produce a finding that it replicable but as little or no resemblance to how we actually behave, in the real world [19]. Yu and Smith’s study, looking at how social factors influence sustained attention, a cognitive function that is normally studied in individuals in isolation, is an important reminder of this fact.

Figure legend

Figure 1: Illustration of the experiment from Yu and Smith.
Top left: the experimental set-up. Parents and children played with toys across a table, while their eye movements were monitored using head-mounted eyetrackers. Top centre and top right – illustrations of gaze footage from the infant's and the parent's perspective. Middle – sample raw gaze footage showing a child's and parent's Region of Interest (ROI). Instances in which the child was looking at the red object are drawn red, and so on. Bottom – the raw gaze footage subdivided between periods of Sustained Attention (defined as the child's attention to a particular object that lasted for 3 seconds or more) and Joint Attention (defined as when parent and child were both attending to the same object). The experiment compared incidents of Sustained Attention that occurred with, and without, concurrent Joint Attention.

References

1 - James, W. (1890). Principles of Psychology, (London: Penguin Classics), p.403

2 **-** Yu, C. and Smith, L.B. (2016). The social origins of sustained attention in one-year-old human infants. Curr. Biol., This issue.

3 **-** Thelen, E. and Smith, L.B. (1994). A Dynamic Systems Approach to the Development of Cognition and Action. (MA, US: MIT Press).

4 **-** Smith, L. and Gasser, M.(2005). The development of embodied cognition: Six lessons from babies. Art. Life. 11(1-2), 13-29.

5 **–** Smith, L. B., Yu, C. and Pereira, A.F. (2011). Not your mother's view: the dynamics of toddler visual experience. Dev. Sci. 14(1), 9-17.

6 - Yu, C. and Smith, L.B. (2012). Embodied attention and word learning by toddlers. Cogn. 125(2), 244-262.

7 - Itti, L. and Baldi, P. (2009). Bayesian surprise attracts human attention. Vis. Res. 49(10), 1295-1306.

8 - Rose, S. A., Feldman, J.F. and Jankowski, J.J.(2002). Processing speed in the 1st year of life: A longitudinal study of preterm and full-term infants. Dev. Psychol. 38(6), 895-902.

9 - Richards, J. E. (2004). Attentional inertia in children's extended looking at television. Adv. Child Dev. & Beh., 32 (32), 163-212.

10 – Feldman, R., Greenbaum, C.W. and Yirmiya, N. (1999). Mother-Infant Affect Synchrony as an Antecedent of the Emergence of Self-Control. Dev. Psychol. 35(5), 223-231.

11 - Feldman, R. (2003). Infant-mother and infant-father synchrony: the coregulation of positive arousal. Inf. Ment. Health J 24(1), 1-23.

12 - Cohn, J. F. and Tronick, E.Z. (1988). Mother-Infant Face-to-Face Interaction: Influence is Bidirectional and Unrelated to Periodic Cycles in Either Partner's Behavior. Dev Psychol. 24(3), 386-392.

13 - Aston-Jones, G. and J. D. Cohen (2005). An integrative theory of locus coeruleus-norepinephrine function: Adaptive gain and optimal performance. Ann. Rev. Neurosci. 28, 403-450.

14 - Wass, S. V., Porayska-Pomsta, K. and Johnson, M.H. (2011). Training attentional control in infancy. Curr. Biol. 21(18), 1543-1547.

15 - Goldsmith, D. E. and Rogoff , B. (1997). Mothers' and toddlers' coordinated joint focus of attention: Variations with maternal dysphoric symptoms. Dev. Psychol. 33, 113-119.

16 - Vally, Z., Murray, L., Tomlinson, M. and Cooper, P.J. (2015). The impact of dialogic book-sharing training on infant language and attention: a randomized controlled trial in a deprived South African community. J. Child Psychol. and Psychiat. 56(8), 865-873.

17 - Dumas, G., Nadel, J., Soussignan, R., Martinerie, J. and Garnero, L. (2010). Inter-Brain Synchronization during Social Interaction. PLoS ONE 5(8), e12166.

18 - Open Science Collaboration (2015). Estimating the reproducitbility of psychological science. Science 349 (6251), aac4716

19 - Wass, S. V. (2014). Comparing methods for measuring peak look duration: are individual differences observed on screen-based tasks also found in more ecologically valid contexts? Inf. Beh. & Dev. 37(3), 315-325.

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