



But do you think I'm cool? Developmental differences in striatal recruitment during direct and reflected social self-evaluations



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ABSTRACT

The current fMRI study investigates the neural foundations of evaluating oneself and others during early adolescence and young adulthood. Eighteen early adolescents (ages 11–14, $M = 12.6$) and 19 young adults (ages 22–31, $M = 25.6$) evaluated whether academic, physical, and social traits described themselves directly (direct self-evaluations), described their best friend directly (direct other-evaluations), described themselves from their best friend's perspective (reflected self-evaluations), or in general could change over time (control malleability-evaluations). Compared to control evaluations, both adolescents and adults recruited cortical midline structures during direct and reflected self-evaluations, as well as during direct other-evaluations, converging with previous research. However, unique to this study was a significant three-way interaction between age group, evaluative perspective, and domain within bilateral ventral striatum. Region of interest analyses demonstrated a significant evaluative perspective by domain interaction within the adolescent sample only. Adolescents recruited greatest bilateral ventral striatum during reflected social self-evaluations, which was positively correlated with age and pubertal development. These findings suggest that reflected social self-evaluations, made from the inferred perspective of a close peer, may be especially self-relevant, salient, or rewarding to adolescent self-processing – particularly during the progression through adolescence – and this feature persists into adulthood.

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We are more or less unconsciously seeing ourselves as we think others who are important to us and whose opinions we trust see us.

[Rosenberg \(1979, p. 97\)](#)

1. Introduction

1.1. Adolescent self-concept development and peer influence

Adolescence is a key point in a young child's life, marking the physical, psychological, and social transition from childhood to adulthood and characterized by significant changes in self-understanding, person-perception, and social influences. This stage is an important time for self-exploration and identity development (Erikson, 1963), as youths are introduced to new environments, new roles, and new role models – suggesting that one apt way of describing adolescence is a period of

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self-concept instability (Rosenberg, 1979; Shirk and Renouf, 1992). Two major changes in adolescent self-processing include the *content of* and *contextual influences on* self-descriptions. Changes in content are largely driven by the acquisition of advanced cognitive abilities, resulting in the greater use of psychological and abstract terminology in adolescent self-descriptions (Broughton, 1978; Harter, 1990; Rosenberg, 1979; Secord and Peevers, 1974; Selman, 1980; Steinberg and Morris, 2001). Adolescents also develop increasingly differentiated and individuated self-representations, which vary across domains and relational contexts (Harter, 1990, 1999; Harter et al., 1998; Marsh, 1989; Masten et al., 1995; Ray et al., 2009), resulting in the development of “multiple selves” (Harter, 1998). Adolescents may view themselves differently at school as students, at home as children, and with peers as friends, revealing distinct contextual influences on self-perceptions.

At the intersection between content and contextual influences, social competence, in particular, becomes highly salient (Damon and Hart, 1982, 1988; Harter, 1999; Montemayor and Einsen, 1977; Rosenberg, 1979). In a trend that Steinberg and Silverberg (1986) referred to as a dependency tradeoff, adolescents spend significantly less time with parents and more time with peers (Collins and Russell, 1991; Csikszentmihalyi and Larson, 1984; Larson and Richards, 1991), which coincides with a similar shift in influence. As the capacity and tendency for self-reflection and social perspective-taking increases (Choudhury et al., 2006; Damon and Hart, 1982; Dumontheil et al., 2009; Montemayor and Einsen, 1977; Selman, 1980), adolescents become more self-conscious (Elkind and Bowen, 1979; Rosenberg, 1979; Selman, 1980), show a greater interest in the perceived opinions of others (Elkind, 1967), and put greater weight on peer evaluations (Buhrmester, 1996; Sussman et al., 1994). Thus, for better or for worse, peers serve as strong role models and important sources of social feedback for adolescent self-evaluations (Harter, 1999; Nurmi, 2004).

1.2. A developmental social neuroscience approach

While behavioral trajectories of self-development have been studied for decades, as summarized above, a novel line of research is exploring adolescent self-processing at the neural level. Adopting a developmental social neuroscience approach offers an alternative to the common reliance on self-report methodologies, which may suffer from explicit and implicit participant biases. This approach may also help connect the underlying social, cognitive, and biological processes involved in self-development (Pfeifer et al., 2013b; Pfeifer and Peake, 2011).

The current study was designed to reveal distinct neural patterns associated with personal and perceived peer evaluations across multiple domains, which would imply distinct influences on self-concept development. Specifically, we examined the patterns of activity supporting early adolescent and young adult direct self-evaluations (first-person evaluations about the participant), direct close other-evaluations (first-person evaluations about the participant's best friend), and reflected self-evaluations

(third-person evaluations about the participant, from the best friend's perspective). Furthermore, we examined the distinct influences of personal and perceived peer evaluations across academic, physical, and social domains. Finally, we explored how pubertal development relates to adolescents' neural activity. The brief neuroimaging review that follows provides a foundation for the current study.

1.3. Adult neuroimaging research on self-processing

Researchers have extensively investigated the neural correlates of self-evaluation and self-reflection within adult samples using functional magnetic resonance imaging (fMRI). Typically, participants have evaluated the descriptiveness of personality traits or made mental state attributions for oneself and an “other” target. Reviews and meta-analyses (Northoff et al., 2006; Pfeifer and Peake, 2011; Qin and Northoff, 2011) have highlighted the integral role of cortical midline structures (CMS), consisting of medial prefrontal cortex (mPFC; including dorsal, anterior rostral, and ventral aspects, as well as adjacent regions of anterior cingulate cortex [ACC]) and medial posterior parietal cortex (mPPC; including precuneus [Prec], posterior cingulate cortex [PCC], and retrosplenial cortex), in self-processing. These CMS support both self-reference (Zhu et al., 2012) and self-relevance (Moore et al., 2013; Moran et al., 2011). Additional regions engaged in these processes include striatal regions representing salience, valuation, and reward; temporal and parietal regions supporting social cognition and mental state attribution (such as temporoparietal junction [TPJ], posterior superior temporal sulcus [pSTS], and temporal poles); as well as hippocampus and insula.

1.4. Pediatric neuroimaging research on direct self- and other-processing

There are relatively few neuroimaging studies examining self-processing within developmental samples. Thus, it is difficult to ascertain the full extent to which the neural correlates of adolescent and adult self-evaluations are similar, and if neural patterns generalize across multiple domains. Previous research has highlighted the role of CMS and striatal regions in youth self-processing, converging with the adult literature (Ersner-Hershfield et al., 2009; Northoff et al., 2006). Ray et al. (2009) found that self-referential memory in male youths (7–13 yo) was positively correlated with activity in rostral ACC (as well as subgenual ACC, medial orbital frontal cortex, caudate, and bilateral inferior frontal regions), and suggested that rostral ACC, in particular, is a neural substrate of psychological self-representations. Research by Pfeifer et al. (2007, 2013b) similarly underscored the role of CMS and ventral striatum (VS) in self-other differentiation. In a cross-sectional study examining self-evaluations, preadolescents (9–10 yo) and young adults (23–31 yo) recruited greater mPFC during direct self-evaluations and greater mPPC during direct other-evaluations about a fictional character, Harry Potter (Pfeifer et al., 2007). However,

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