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Short Communication

Spatial perspective taking is related to social intelligence and attachment style

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ABSTRACT

Individuals differ both in spatial and social perspective-taking, yet the links between the two are not well understood. Individuals differ in the spatial perspective they naturally adopt, but also in their ability to change perspectives. The present study investigated whether individual differences in spatial perspective-taking are related to social intelligence and adult attachment style. Spatial perspective-taking was measured using a graphesthesia task, in which ambiguous tactile symbols can be interpreted from different spatial perspectives. The task identified the spatial perspective individuals spontaneously adopted, then assessed the ability to change between natural and unnatural perspectives. Participants demonstrated a cost of switching to an unnatural perspective and a benefit of returning to their natural perspective. A greater cost of switching to an unnatural perspective was associated with lower anxious attachment. A stronger benefit of returning to one's natural perspective was associated with higher social intelligence. These findings suggest that a strong grounding in one's natural spatial perspective is associated with lower interpersonal anxiety and higher social intelligence. Building on these results, future studies should further investigate causal relationships between social and spatial perspective-taking.

1. Introduction

Individuals often demonstrate a preference for one spatial perspective. For example when recognising ambiguous tactile stimuli individuals spontaneously interpret the stimulus from a self-centred perspective, or from a decentred perspective (Arnold, Spence, & Auvray, 2016; Ferrè, Lopez, & Haggard, 2014). Furthermore, individuals differ considerably in the strength of their natural perspective, with variability in the cost associated with adopting different perspectives. Why exactly individuals differ in their spatial perspective-taking abilities remains a key area of investigation (Bukowski & Samson, 2017).

Perspective-taking is described in the literatures of spatial and social cognition, with similar terms used to describe taking another's spatial and mental point of view (Proulx, Todorov, Aiken, & de Sousa, 2016). Recent studies show that performance in spatial perspective-taking tasks is associated with social skills (Shelton, Clements-Stephens, Lam, Pak, & Murray, 2012) as well as emotional empathy (Chiu & Yeh, 2018). Social abilities also predict different approaches to spatial perspective-taking tasks, such that individuals with higher social skills (Kessler & Wang, 2012) as well as empathy (Erle & Topolinski, 2015) engage more in 'embodied' strategies (i.e. mentally rotating themselves), rather than rule-based/object rotation strategies. While spatial perspective-taking abilities appear related to cognitive and affective perspective-taking, this does not appear to be the case for other non-perspective-taking spatial abilities such as mentally rotating objects (Erle & Topolinski, 2017; Erle, Barth, & Topolinski, 2019). Furthermore, impairments in spatial perspective-taking and mentalising about others' beliefs are found in individuals with autism spectrum disorder (Hamilton, Brindley, & Frith, 2009) as well as schizophrenia (Langdon & Coltheart, 2001), suggesting potential links between spatial and mental perspective-taking abilities.

How individuals perceive, attend to and process information of social significance is also thought to be shaped by one's attachment style (Bartholomew & Horowitz, 1991). Attachment is typically modelled along two dimensions labelled attachment *anxiety* characterised by a fear of interpersonal rejection and abandonment, and *avoidance* characterised by an exaggerated sense of independence and emotional distancing from others. Recent evidence has shown that insecure attachment styles predict lower emotional intelligence (Hamarta, Deniz, & Saltali, 2009) and social skills (DiTommaso, Brannen-McNulty, Ross, & Burgess, 2003). However, whether attachment styles are related to

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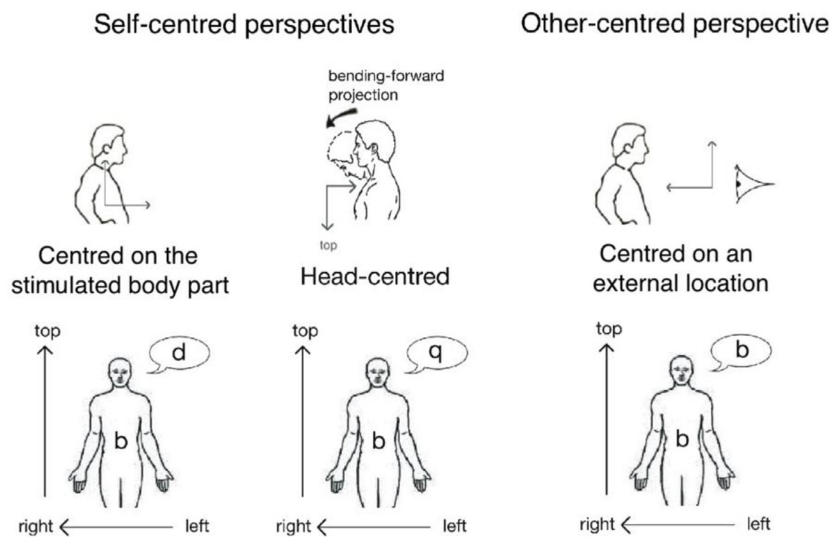

Fig. 1. Graphesthesia task. For the letter "b" traced on the stomach using a 'tactile belt', individuals adopting a trunk-centred perspective report the mirror reversed letter "d", while those adopting a head-centred perspective report the 180°-rotated letter "q", and those adopting a decentred (other-centred) perspective report the letter "b", as if the letter was perceived from the perspective of an external location (adapted from Arnold, Spence, & Auvray, 2016). .

individual differences in spatial perspective-taking remains unknown.

The Graphesthesia task (Arnold, Spence, & Auvray, 2016) provides an ideal tool to investigate perspective-taking. One's spatial perspective is determined by presenting ambiguous tactile stimuli perceived differently from multiple perspectives (see Fig. 1). One's preferred perspective is first obtained when freely recognising the letters, then perspectives are imposed to measure the cost and benefit associated with adopting unnatural and natural perspectives, respectively.

The aim of the present study was to investigate whether the ability to adopt different spatial perspectives is linked to the ability to process social information. Given previous findings that embodied strategies of perspective-taking appear linked to higher social skills (Kessler & Wang, 2012), stronger self-centred natural perspectives may be linked to greater social information processing. Conversely, strong self-centred perspectives may inhibit the ability to adopt another's mental perspective. Beyond social intelligence, we explored relationships between the strength of one's natural spatial perspective and adult attachment styles as well as personality traits, which have so far not been investigated together. To refine the spatial abilities involved, the Object Perspective-Taking Test and the Mental Rotation Test were also assessed.

2. Methods

2.1. Participants

Fifty-four adults were recruited (32 females, $M_{age} = 26.91$ years, $SD = 7.62$, 45 right-handed). A sensitivity analysis using G*power (Erdfelder, Faul, Lang, & Buchner, 2007) indicated that the sample size was sufficient to detect a minimum effect size of $r = 0.37$ with power (1-β) of .80 and the value for Type 1 error probability set at 0.05 (two-tailed). All participants provided informed consent in accordance with the ethical standards outlined by the Declaration of Helsinki (1991). The experiment took approximately two hours to complete.

2.2. Procedure

The Graphesthesia task stimuli were identical to those previously used (Arnold, Spence, & Auvray, 2016) (see Supplementary Information 1 for details about the stimuli and task). The task involved recognising alphanumeric symbols delivered my means of a tactile belt placed on the abdomen. Participants completed 3 sessions, each containing 3 blocks of 16 trials (144 trials in total). In Session 1, participants were free to adopt any perspective to recognize letters traced on the abdomen. In Session 2, they were instructed to adopt a perspective other than their preferred perspective. In Session 3, they were instructed to adopt the perspective they had freely adopted in Session 1. Responses were made by pressing four adjacent keys on a keyboard labelled b, d, p and q with the index finger of their preferred hand. The Mental Rotation Test (MRT) (Vandenberg & Kuse, 1978) and the Object Perspective-Taking Test (OPTT) (Hegarty & Waller, 2004) were also administered (See Supplementary Information 2 for further details on the MRT and OPTT).

Social intelligence was assessed using the Tromsø Social Intelligence Scale (TSIS) questionnaire (Silvera, Martinussen, & Dahl, 2001). Attachment was assessed with the Experiences in Close Relationships-Revised questionnaire (ECR-R, French version) (Favez, Tissot, Ghisletta, Golay & Notari, 2016; Fraley, Waller, & Brennan, 2000) and the Relationships Structures (ECR-RS) questionnaire (Chaperon & Dandeneau, 2017; Fraley, Heffernan, Vicary, & Brumbaugh, 2011). Personality was assessed using the Revised NEO Personality Inventory (NEO-PI-R, French version) (Costa & McCrae, 2008). For more details see Supplementary Information 2.

2.3. Data Analysis

Four participants were excluded due to inconsistency in adopting any one perspective in Session 1 of the Graphesthesia task (<50% of stimuli reported in any one perspective). Following previous analysis of the same task (Arnold, Spence, & Auvray, 2016), separate t-tests for reaction times and accuracy were used to compare Session 1 vs. Session 2 (switch-cost at the session-level), Session 1 Block 3 vs. Session 2 Block 1 (switch-cost at the block-level), Session 2 vs. Session 3 (return-benefit at the session-level), Session 2 Block 3 vs. Session 3 Block 1 (return-benefit at the block-level). Correction for multiple comparisons was made using Bonferroni adjustment (alpha adjusted to 0.025).

Relationships between spatial abilities and questionnaire measures were assessed with Pearson correlation analysis. Where significant violations of the assumptions of normality were found (Shapiro-Wilk p-value < 0.05) Spearman's Rho correlation was used. The alpha was set to 0.01 (two-tailed) for the correlation analyses in order to control for inflation of Type I error rate.

3. Results

3.1. Proportions

In Session 1, 50% of participants adopted a trunk-centred perspective, 32% a head-centred perspective and 18% a decentred perspective, closely replicating previous findings (Arnold, Spence, & Auvray, 2016).

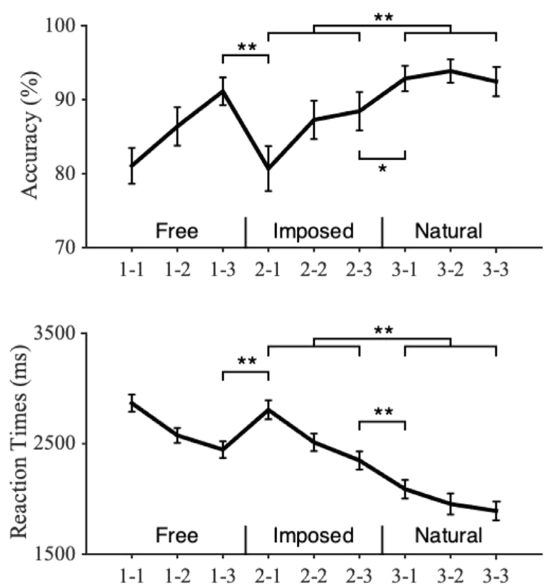

Fig. 2. Accuracy and reaction times. $p < .01$, $*p < .025$. Error bars show ± SEM.

A chi-square goodness of fit test showed that the occurrence of self-centred (0.82) and decentred (0.18) perspectives significantly differed from equal ($\chi^2(1) = 20.48$, $p < .001$).

3.2. Cost of switching

There was a significant cost at the block-level when changing perspectives (Fig. 2) with a decrease of 10.4% accuracy (95% CI [4.56, 16.32], $SE = 2.9$; $t(49) = 3.57$, $p = .001$, $d = 0.505$). Reaction times also increased by 360 ms (95% CI [190, 530], $SE = 84.62$; ($t(49) = 4.26$, $p < .001$, $d = 0.602$). The cost of switching was not significant at the session-level for accuracy (95% CI [4.06, 5.55], $t(49) = -0.31$, $p = .756$, $d = -0.044$) or for reaction times (95% CI [58.76, 206.24], $t(49) = -1.12$, $p = .269$, $d = -0.158$, 95%).

3.3. Benefit of returning

Participants' performance significantly improved when returning to their natural perspective (block-level) by 4.4% accuracy (95% CI [0.69, 8.11], $SE = 1.85$, $t(49) = 2.38$, $p = .021$, $d = 0.021$) and a decrease in reaction times of 260 ms (95% CI [101, 418], $SE = 79.03$, $t(49) = -3.29$, $p = .002$, $d = -0.465$). Effects also emerged at the session-level with a significant increase of 7.6% accuracy (95% CI [4.66, 10.56], $SE = 1.47$; $t(49) = 5.18$, $p < .001$, $d = 0.733$) and a mean decrease in reaction times of 578 ms (95% CI [428, 727], $SE = 75.45$; $t(49) = 7.76$, $p < .001$, $d = 1.097$).

3.4. Social intelligence

A significant negative correlation was found between Social Information Processing and the return-benefit at the session-level ($r(49) = -0.39$, $p = .005$, 95% CI [−0.60, −0.13]). Thus, participants with higher scores on Social Information Processing had faster reaction times when returning to their natural perspective in Session 3 (see Fig. 3). Social Information Processing was also positively correlated with the percentage of egocentred responses in Session 1 ($r_s(49) = 0.34$, $p = .016$, 95% CI [.079, 0.57]), although this was marginal with an alpha cut-off of 0.01. See Supplementary Table 1 for a summary of the correlations.

3.5. Adult attachment

A significant positive correlation was found between attachment anxiety in general (ECR-RS) and the switch-cost at the block-level ($r_s(49) = 0.38$, $p = .006$, 95% CI [.11, 0.59]; Fig. 4.A). The lower a participant's score on anxious attachment was, the lower their accuracy when switching to an unnatural perspective (greater switch-cost). A significant positive correlation was also found between attachment anxiety and scores on the MRT ($r(49) = 0.37$, $p = .007$, 95% CI [.10, 0.58]; Fig. 4.B). The higher a participant's score on anxious attachment, the higher their mental rotation score was.

3.6. Personality traits

Neuroticism scores were negatively correlated with accuracy on the MRT ($r(49) = -0.30$, $p = .031$, 95% CI [.02, 0.53]) and positively correlated with scores (errors) on the OPTT ($r(49) = 0.30$, $p = .034$, 95% CI [.02, 0.53]), although these were not significant with an alpha cut-off of 0.01. No further measures correlated with personality traits (all p-values > 0.05).

4. Discussion

Relationships between spatial and mental perspective-taking were investigated using a Graphesthesia task and self-report measures of social intelligence, adult attachment and personality traits. Participants freely recognised ambiguous tactile stimuli in order to identify the spatial perspective spontaneously adopted. In line with previous findings (Arnold, Spence, & Auvray, 2016), 82% of participants naturally adopted self-centred perspectives (50% trunk-centred and 32% head-centred) and 18% naturally adopted a decentred perspective. Perspectives were then imposed to assess variability in the strength of one's natural perspective and whether this variability was related to measures of social intelligence, adult attachment and personality traits.

Higher scores on Social Information Processing were related to a stronger benefit of returning to one's natural perspective. This suggests that the ability to understand and predict information regarding social relations is related to a strong natural perspective. Given that the majority of participants (82%) naturally adopted a self-centred perspective, this suggests that a stronger self-centred perspective helps the recognition and understanding of the mental states of others. This is in line with a recent study reporting return-benefits from a decentred to a self-centred perspective (but not the reverse) being associated with higher emotional empathy (Chiu & Yeh, 2018). Together these findings suggest that a stable self-centred perspective is related to improved social-affective information processing. The ability to appropriately infer the mental states of others may be quite intimately related to processes of self-representation, as recent findings have shown that adopting another's perspective is in fact related to higher interoception (Erle, 2019) and self-other distinction (Steinbeis, 2016).

Furthermore, greater costs when switching to unnatural spatial perspectives were associated with lower self-reported attachment anxiety, suggesting that a strong natural perspective is associated with lower levels of interpersonal anxiety. Given that the majority of participants naturally adopted a self-centred perspective, the cost of switching is dominated by those switching from a self-centred to a decentred perspective. Together, this suggests that higher levels of attachment anxiety may bias individuals to more frequently adopt another's perspective, possibly reflecting their need to take into account how others perceive them. Higher attachment anxiety was also associated with improved mental rotation scores, a measure of non-perspective-taking mental transformations (Hegarty & Waller, 2004). How different social processes are related to different aspects of spatial cognition, as a function of their requirement for perspective-taking, is an intriguing question that future work should investigate further. This line of research might help to disentangle which social-cognitive processes may be grounded in different aspects of spatial cognition (Erle & Topolinski, 2017).

These results suggest that spatial perspective-taking is related to

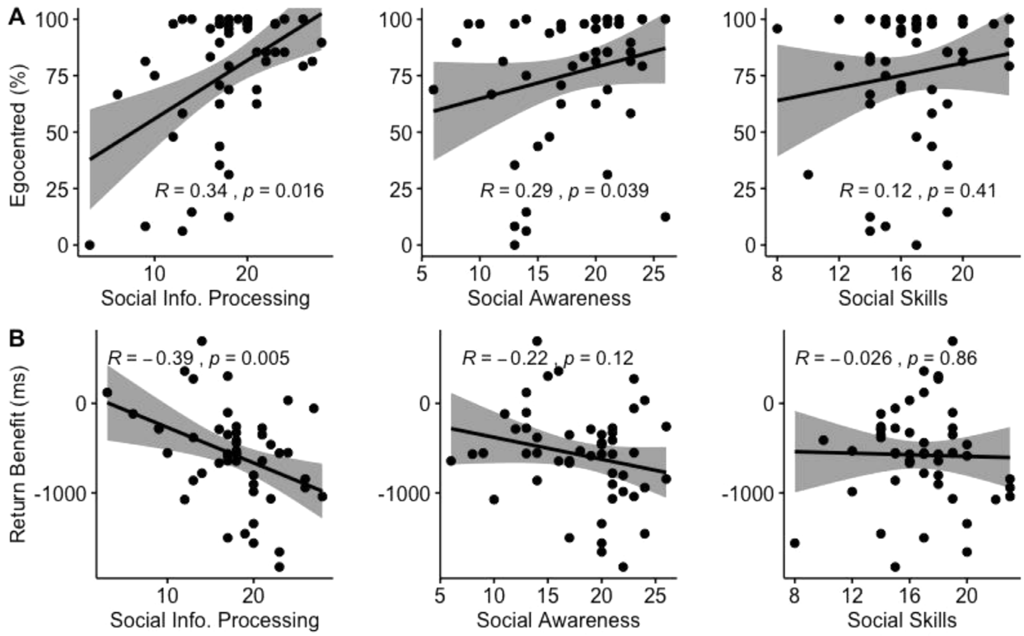

Fig. 3. Scatter plots of scores on the Tromsø Social Intelligence Scale; from left to right: Social Information Processing, Social Awareness and Social Skills plotted against A) percentage of egocentred responses in Session 1 (i.e. "Egocentred%") and B) reaction time return-benefit in milliseconds ("ms", Session 3 minus Session 2). Shaded areas show ± 95% confidence intervals.

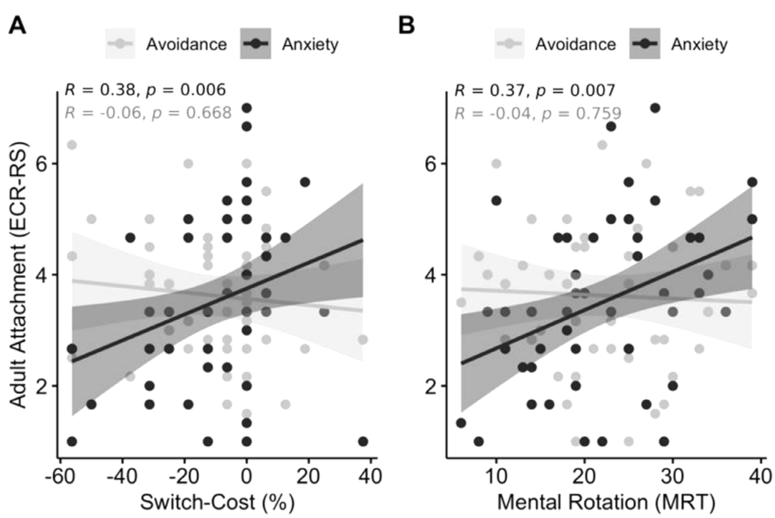

Fig. 4. Scatter plots showing the relationships between attachment styles of Avoidance (light grey) and Anxiety (dark grey) and A) Cost in accuracy of switching from one's natural perspective to an unnatural perspective (Switch-Cost), with lower values indicating greater Switch-Cost (decrease in recognition accuracy when switching from natural to unnatural perspective); and B) Mental Rotation Test scores, higher values indicate higher scores. Shaded areas show ± 95% confidence intervals.

social intelligence and attachment style, however they do not provide information about causal relationships. Indeed, theoretical frameworks rarely posit whether individual differences in social cognition shape biases in spatial cognition, or the reverse. Theories of embodied cognition state that abstract mental representations are grounded in sensorimotor processes (Barsalou, 2008), thus implying a common mechanism underlying both spatial and social perspective-taking. However, the direction of effect in relationships between spatial and social cognition remains a key area of investigation for future research.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.paid.2019.109726.

References

Arnold, G., Spence, C., & Auvray, M. (2016). Taking someone else's spatial perspective: Natural stance or effortful decentring. *Cognition, 148*, 27–33. https://doi.org/10.1016/j.cognition.2015.12.006.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*, 617–645. https://doi.org/10.1146/annurev.psych.59.1030.

Bartholomew, K., & Horowitz, L. M. (1991). Attachment styles among young adults: A test of a four-category model. *Journal of Personality and Social Psychology, 61*(2), 226–244. https://doi.org/10.1037/0022-3514.61.2.226.

Bukowski, H., & Samson, D. (2017). New insights into the inter-individual variability in perspective taking. *Vision, 1*(1), 8. https://doi.org/10.3390/vision1010008.

Chaperon, & Dandeneau, S. (2017). Le questionnaire sur les structures relationnelles : Adaptation et validation de la version française du experiences in close relationships–relationship structures questionnaire. *European Review of Applied Psychology, 67*(4), 213–221. https://doi.org/10.1016/j.erap.2017.04.002.

Chiu, C. D., & Yeh, Y. Y. (2018). In your shoes or mine? shifting from other to self perspective is vital for emotional empathy. *Emotion, 18*(1), 39. https://doi.org/10.1037/emo0000346.

Costa, P. T., & McCrae, R. R. (2008). The revised neo personality inventory (NEO-PI-R). *in*

The SAGE Handbook of Personality Theory and Assessment, 2. https://doi.org/10.4135/9781849200479.n9 *Personality Measurement and Testing*.

DiTommaso, E., Brannen-McNulty, C., Ross, L., & Burgess, M. (2003). Attachment styles, social skills and loneliness in young adults. *Personality and Individual Differences, 35*(2), 303–312. https://doi.org/10.1016/S0191-8869(02)00190-3.

Erdfelder, E., Faul, F., Lang, A.-G., & Buchner, A. (2007). GPOWER: A general power analysis program. *Behavior Research Methods, 28*(1), 1–11. https://doi.org/10.3758/BF03193146.

Erle, T. M. (2019). Level-2 visuo-spatial perspective-taking and interoception - More evidence for the embodiment of perspective-taking. *PloS one, 14*(6), https://doi.org/10.1371/journal.pone.0219005.

Erle, T. M., Barth, N., & Topolinski, S. (2019). Egocentrism in sub-clinical depression. *Cognition and Emotion, 33*(6), 1239–1248. https://doi.org/10.1080/02699931.2018.1552120.

Erle, T. M., & Topolinski, S. (2015). Spatial and empathic perspective-taking correlate on a dispositional level. *Social Cognition, 33*(3), 187–210. https://doi.org/10.1521/soco.2015.33.3.187.

Erle, T. M., & Topolinski, S. (2017). The grounded nature of psychological perspective-taking. *Journal of Personality and Social Psychology, 112*(5), 683. https://doi.org/10.1037/pspa0000081.

Favez, N., Tissot, H., Ghisletta, P., Golay, P., & Notari, S. C. (2016). Validation of the french version of the experiences in close relationships- revised (ECR-R) adult romantic attachment questionnaire. *Swiss Journal of Psychology*. https://doi.org/10.1024/1421-0185/a000177.

Ferrè, E. R., Lopez, C., & Haggard, P. (2014). Anchoring the self to the body: Vestibular contribution to the sense of self. *Psychological Science, 25*(11), 2106–2108. https://doi.org/10.1177/0956797614547917.

Fraley, R. C., Heffernan, M. E., Vicary, A. M., & Brumbaugh, C. C. (2011). The experiences in close relationships-relationship structures questionnaire: A method for assessing attachment orientations across relationships. *Psychological Assessment, 23*(3), 615. https://doi.org/10.1037/a0022898.

Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An item response theory analysis of self-report measures of adult attachment. *Journal of personality and social psychology, 78*(2), 350. https://doi.org/10.1037/a0022898.

Hamarta, E., Deniz, M. E., & Saltali, N. (2009). Attachment styles as a predictor of emotional intelligence. *Educational Sciences: Theory and Practice, 9*(1), 213–229.

Hamilton, A. F., Brindley, R., & Frith, U. (2009). Visual perspective taking impairment in children with autistic spectrum disorder. *Cognition, 113*(1), 37–44. https://doi.org/10.1016/j.cognition.2009.07.007.

Hegarty, M., & Waller, D. (2004). A dissociation between mental rotation and perspective-taking spatial abilities. *Intelligence, 32*(2), 175–191. https://doi.org/10.1016/j.intell.2003.12.001.

Kessler, K., & Wang, H. (2012). Spatial perspective taking is an embodied process, but not for everyone in the same way: Differences predicted by sex and social skills score. *Spatial Cognition & Computation, 12*(2–3), 113–158. https://doi.org/10.1080/13875868.2011.634533.

Langdon, R., & Coltheart, M. (2001). Visual perspective-taking and schizotypy: Evidence for a simulation-based account of mentalizing in normal adults. *Cognition, 82*, 1–26.

Proulx, M. J., Todorov, O. S., Aiken, A. T., & de Sousa, A. A. (2016). Where am I? who am I? the relation between spatial cognition, social cognition and individual differences in the built environment. *Frontiers in Psychology, 7*, 64. https://doi.org/10.3389/fpsyg.2016.00064.

Shelton, A. L., Clements-Stephens, A. M., Lam, W. Y., Pak, D. M., & Murray, A. J. (2012). Should social savvy equal good spatial skills? the interaction of social skills with spatial perspective taking. *Journal of Experimental Psychology: General, 141*(2), 199. https://doi.org/10.1037/a0024617.

Silvera, D. H., Martinussen, M., & Dahl, T. I. (2001). The tromsø social intelligence scale, a self-report measure of social intelligence. *Scandinavian Journal of Psychology, 42*(4), 313–319. https://doi.org/10.1111/1467-9450.00242.

Steinbeis, N. (2016). The role of self-other distinction in understanding others' mental and emotional states: Neurocognitive mechanisms in children and adults. *Philosophical Transactions of the Royal Society B: Biological Sciences, 371*(1686), 20150074. https://doi.org/10.1098/rstb.2015.0074.

Vandenberg, S. G., & Kuse, A. R. (1978). Mental rotations, a group test of three-dimensional spatial visualization. *Perceptual and Motor Skills, 47*(2), 599–604. https://doi.org/10.2466/pms.1978.47.2.599.