Anxiety Impairs Spontaneous Perspective Calculation:
Evidence from a Level-1 Visual Perspective-Taking Task

Andrew R. Todd^{a*} and Austin J. Simpson^a

^aDepartment of Psychological and Brain Sciences, University of Iowa, Iowa City, IA, USA

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*Corresponding author:

E-mail: andrew-todd@uiowa.edu

Abstract

Reasoning about other people's mental states is central to social life. Yet, even neuro-typical adults sometimes have perspective-taking difficulties, particularly when another's perspective conflicts with their own. In two experiments, we examined the cognitive mechanisms underlying an affective factor known to hinder perspective taking in adults: anxiety. Using a level-1 visual perspective-taking task, we found that incidentally experiencing anxiety, relative to neutral feelings and anger, impaired the spontaneous calculation of what another social agent can see. Feeling anxious did not, however, impede perspective calculation with a non-social entity, suggesting that anxiety's disruptive effects may be particularly pronounced for social aspects of cognition. These findings help elucidate the mechanisms underlying the effects of incidental emotions on perspective taking and inform debates about "implicit" forms of mentalizing.

Keywords: anxiety; emotion; implicit mentalizing; theory of mind; visual perspective taking

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Reasoning about the content of other people's minds – often called mentalizing or perspective taking – is central to managing most aspects of social life. Yet, at times, even neurotypical adults err in such endeavors, particularly if others' perspectives conflict with their own (Birch & Bloom, 2004; Nickerson, 1999). When might these mentalizing difficulties be exacerbated? Recent evidence suggests that particular emotions can hinder perspective taking (e.g., Bukowski & Samson, 2016; Converse et al., 2008). In one set of experiments, for example, anxiety – a high-arousal emotion triggered by situations that are novel, threatening, or otherwise have the potential for adverse outcomes (Brooks & Schweitzer, 2011) – impeded adults' ability to infer others' spatial perspectives and beliefs (Todd et al., 2015). Our aim here was to shed light on the mechanisms underlying these anxiety-induced perspective-taking difficulties.

Abundant research has sought to elucidate the cognitive processes underlying mentalizing (Apperly, 2010). On one notable view, ascribing mental states to oneself and others involves two distinct processes: an implicit *calculation* of candidate mental contents (e.g., what a person sees, knows, or wants) and an explicit *selection* of the most plausible among these candidates while inhibiting competitors (Leslie et al., 2004, 2005; see also Apperly & Butterfill, 2009). Because most mentalizing tasks, including those used by Todd et al. (2015), assess both the calculation and selection of another person's perspective while inhibiting one's own perspective, they necessarily conflate these processes (Ramsey et al., 2013). With the rise of indirect measures of perspective taking that monitor eye gaze (e.g., Rubio-Fernández, 2013; Schneider et al., 2012) and other spontaneous behaviors (e.g., Cohen & German, 2009; Kovács et al., 2010), however, distinguishing among these processes is possible.

Samson et al. (2010) recently introduced one such measure: a level-1 visual perspective-taking (hereafter, L1-VPT) task¹ wherein adults view a human avatar in a room with dots on the walls. On some trials, the avatar and participants can see the same number of dots; on other trials, the avatar cannot see some of the dots that are visible to participants. Two interference effects commonly emerge in this task: First, responding from the avatar's perspective is more difficult when it conflicts with what participants themselves can see. This *egocentric* intrusion resembles other egocentric biases commonly found on tasks requiring explicit judgments of others' perspectives (e.g., Epley et al., 2004; Keysar et al., 2003; Todd et al., 2011). Second, reporting one's own perspective is more difficult when it conflicts with what the avatar can see. This *altercentric* intrusion is thought to reflect a rapid and efficient consideration of the avatar's visual perspective and thus provides an indirect measure of spontaneous perspective calculation (e.g., Qureshi et al., 2010; Ramsey et al., 2013; Smith & Mackie, in press). We used this L1-VPT task in the current work to examine the effects of incidental experiences of anxiety (i.e., anxiety triggered in an unrelated prior context; Bodenhausen, 1993) on processes of perspective calculation and perspective selection.

How might feeling anxious affect these processes? Based on prior findings suggesting that anxiety increases egocentric biases in explicit forms of mentalizing (Todd et al., 2015), we anticipated that experiencing anxiety would increase the relative difficulty of judging the avatar's perspective when it conflicts with one's own perspective versus when self and other perspectives are aligned (i.e., anxiety should increase egocentric intrusion). Insofar as these anxiety-induced deficits in explicit mentalizing are accompanied by, or even rooted in, complementary changes in implicit cognitive processes (see Gawronski & Bodenhausen, 2006), moreover, anxiety might

¹Level-1 VPT entails understanding *what* someone sees; this can be contrasted with level-2 VPT, which entails understanding *how* someone sees something (Flavell et al., 1981).

also be expected to weaken spontaneous tendencies to calculate others' perspectives. This proposition accords with evidence of comparable effects of incidental emotions on explicit and implicit social judgments (e.g., Bodenhausen et al., 1994; DeSteno et al., 2004). On this *perspective-calculation* account, feeling anxious, despite increasing egocentric intrusion, should *decrease* altercentric intrusion. Note that anxiety-impaired perspective calculation could also be revealed by an increased difficulty in judging the avatar's perspective even when it aligns with one's own perspective. An effect here where there is no perspective conflict to resolve—and thus little need to recruit effortful processes—may also reflect deficiencies in a rapid and efficient form of perspective calculation (Ramsey et al., 2013; Samson et al., 2010).

An alternative hypothesis derives from research linking anxiety to decrements in executive functioning (Eysenck et al., 2007; Shields et al., 2016). In line with theoretical claims that perspective selection (but not perspective calculation) is cognitively demanding (e.g., Apperly & Butterfill, 2009; Leslie et al., 2004, 2005), one study found that taxing participants' executive resources (via a dual-task procedure) increased the difficulty of responding when the avatar's perspective was in conflict with one's own, regardless of whose perspective was under consideration (Qureshi et al., 2010). On this *perspective-selection* account, the executive deficits that typically accompany anxiety should impair the ability to select among competing perspectives. In this case, then, feeling anxious would be expected to increase the difficulty of responding whenever there is a self–other perspective conflict to resolve, thereby producing increases in both egocentric intrusion and altercentric intrusion.

We tested these different predictions in three experiments wherein participants underwent an emotion induction, after which they completed Samson et al.'s (2010) L1-VPT task. In Experiment 1, we compared anxiety with neutral feelings. In Experiment 2, we compared anxiety

with anger. Additionally, in Experiment 2b, we tested whether any observed effects of anxiety on L1-VPT could be accounted for by more domain-general cognitive processes rather than processes that are specific to social cognition.

Experiment 1

Method

Participants. Native English-speaking undergraduates ($N=152$) participated for course credit. We excluded data from 1 participant who did not complete the emotion induction and 4 participants with errors on >30% of trials on the L1-VPT task (Samson et al., 2010), leaving a final sample of 147 (82 women, 62 men, 3 unreported).

Procedure.

Emotion induction. Participants first underwent an emotion induction. They described in detail a time when they felt very *anxious* (instructions adapted from Cataldo & Cohen, 2015) or, in a *neutral-emotion* condition, what they did the previous day. Prior research has found that this type of autobiographical recall task is a valid means of inducing specific incidental emotions, including anxiety-related states (Lench et al., 2011).

L1-VPT task. Next, participants completed an L1-VPT task (Samson et al., 2010). They saw a room with dots on the left and right walls. A human avatar stood in the center of the room facing left or right. On *other* trials, participants responded from the avatar's perspective; on *self* trials, participants responded from their own perspective. Additionally, on *consistent* trials, the number of dots visible to the avatar was identical to the number visible to participants; on *inconsistent* trials, the avatar could not see some of the dots that were visible to participants. Each trial began with a fixation cross (500 ms), followed by a cue ("YOU" or "HE") indicating whose perspective to respond from (750 ms), and then another cue (0–3) indicating the number

of dots to verify (750 ms). Finally, the room appeared (on screen until participants responded). Participants' objective was to verify if the number of dots on the wall matched or mismatch the given number by pressing one of two response keys as quickly and accurately as possible. Match and mismatch trials occurred with equal frequency, but only match trials were analyzed (Figure 1 displays the different types of match trials). If participants did not respond within a response deadline (2000 ms), a message ("Please try to respond faster!") appeared (1000 ms), after which the next trial began. Incorrect responses triggered a red "X" (1000 ms), after which the next trial began. Participants completed four equivalent blocks of 52 experimental trials; within-block trial order was pseudo-randomized (see Samson et al., 2010, for details). Sixteen practice trials preceded the first block of experimental trials.

Consistent		Inconsistent	
SELF	OTHER	SELF	OTHER

Figure 1. Trial examples on the L1-VPT task (match trials only). Participants verified if a given number (0–3) matched the number of dots visible either from their own perspective (self: “YOU”) or from the avatar’s perspective (other: “HE”). The number of dots visible from each perspective was either the same (consistent) or different (inconsistent). (Not pictured are mismatch trials where the number of dots visible did not match the assigned perspective.)

Manipulation check. Finally, participants indicated how much the event they described made them feel several specific emotions (1=*not at all*, 7=*very much so*). We averaged the anxiety (*anxious, fearful, nervous*; $\alpha=.85$) and neutral (*calm, neutral, unemotional*; $\alpha=.69$) items.

Results

Manipulation check. Experienced anxiety was higher, whereas experienced neutrality was lower, in the anxiety versus the neutral-emotion condition, ($ps < .001$, Hedges' $gs > 1.24$). Furthermore, participants in the anxiety condition reported greater anxiety than neutral feelings, whereas participants in the neutral condition reported greater neutral feelings than anxiety ($ps < .001$, $gs > 0.79$). Table 1 displays descriptive statistics for all experiments; additional content analyses of the emotion-induction essays appear in the Supplemental Material.

Table 1

Experienced emotions by emotion condition (Experiments 1, 2a, and 2b)

Emotion condition	Experienced emotion		
	Anxiety	Neutral	Anger
Experiment 1			
Anxiety	4.14_a (1.64)	2.93 _b (1.33)	
Neutral	2.21 _a (1.19)	4.54_b (1.23)	
Experiment 2a			
Anxiety	4.41_a (1.77)	2.66 _b (1.37)	2.70 _b (1.39)
Anger	2.88 _a (1.85)	2.19 _b (1.25)	5.63_c (1.49)
Experiment 2b			
Anxiety	4.21_a (1.79)	2.79 _b (1.51)	2.76 _b (1.64)
Anger	2.54 _a (1.50)	2.39 _a (1.23)	5.31_b (1.52)

Note. Values in parentheses are standard deviations. The targeted emotion is bolded. Within each row, means with different subscripts differ ($p < .05$).

L1-VPT. We excluded mismatch trials because of systematic differences across trial types (see Samson et al., 2010, for details). We also excluded trials with RTs < 200 ms as anticipations and RTs > 2000 ms as outliers. Furthermore, because our hypotheses concerned the *difficulty* of L1-VPT rather than speed or accuracy per se, following prior L1-VPT research (e.g., Bukowski & Samson, 2016; Qureshi et al., 2010), we integrated speed and accuracy into a single metric of processing costs, or inverse efficiency score, by dividing the mean correct RTs by the

proportion of correct responses (Townsend & Ashby, 1983).^{2,3} Table 2 displays descriptive statistics for all experiments.

Table 2

Processing cost by perspective, consistency, and emotion condition (Experiments 1, 2a, and 2b)

	Perspective and consistency			
	Other		Self	
	Consistent	Inconsistent	Consistent	Inconsistent
Experiment 1				
Anxiety	635 (168)	884 (317)	657 (163)	752 (217)
Neutral	610 (133)	827 (207)	635 (135)	769 (251)
Experiment 2a				
Anxiety	657 (135)	911 (274)	688 (148)	790 (222)
Anger	687 (132)	895 (194)	710 (147)	852 (256)
Experiment 2b				
Anxiety	692 (152)	949 (260)	741 (190)	816 (236)
Anger	706 (177)	957 (263)	770 (233)	811 (242)

Note. Values in parentheses are standard deviations. Processing cost = mean RTs/proportion of correct responses.

A 2 (Emotion) $\times$ 2 (Perspective) $\times$ 2 (Consistency) mixed ANOVA yielded main effects of Perspective (other>self), $F(1, 145)=7.35$, $p=.008$, $\eta_p^2=.05$, and Consistency (inconsistent>consistent), $F(1, 145)=295.04$, $p<.001$, $\eta_p^2=.67$. A Perspective $\times$ Consistency interaction, $F(1, 145)=48.11$, $p<.001$, $\eta_p^2=.25$, further indicated that, as in prior work (e.g., Ramsey et al., 2013; Samson et al., 2010; Surtees et al., 2016), the effect of consistency was stronger on other trials versus self trials (egocentric intrusion>altercentric intrusion).

²Interpreting this metric is problematic when error rates are high or when error rates and RTs are not in unison; thus, its use is recommended only when error rates are low and positively correlated with RTs (Bruyer & Brysbaert, 2011). Both criteria were met in our data.

³Separate analyses on RTs and error rates yielded comparable patterns of results (see the Supplementary Material).

More important for the current work was the effect of emotion on L1-VPT. Contrary to the *perspective-selection* account, the Emotion $\times$ Consistency interaction was not significant ($F < 1$). Nor was the Emotion $\times$ Perspective interaction, $F(1, 145) = 2.27$, $p = .134$, $\eta_p^2 = .02$, though the pattern of means suggests that the difference in processing costs on other trials versus self trials (other > self) was greater in the anxiety condition than in the neutral-emotion condition. In line with the *perspective-calculation* account, however, the 3-way interaction was significant, $F(1, 145) = 4.34$, $p = .039$, $\eta_p^2 = .03$. Inspection of the Perspective $\times$ Consistency interaction within each emotion condition revealed that the underlying pattern (egocentric intrusion > altercentric intrusion) was considerably larger for anxious participants, $F(1, 75) = 41.45$, $p < .001$, $\eta_p^2 = .36$, than for neutral participants, $F(1, 70) = 11.59$, $p = .001$, $\eta_p^2 = .14$.

Figure 2. Processing costs for egocentric intrusion and altercentric intrusion by emotion condition; error bars depict $\pm SEM$ (Experiment 1).

To further specify the 3-way interaction in terms of our hypotheses, we calculated indices of egocentric intrusion (inconsistent-other trials minus consistent-other trials) and altercentric intrusion (inconsistent-self trials minus consistent-self trials). As shown in Figure 2, egocentric intrusion was directionally stronger, $t(145) = 1.14$, $p = .257$, $g = 0.19$, whereas altercentric intrusion

was directionally weaker, $t(145)=1.58$, $p=.116$, $g=0.26$, in the anxiety condition than in the neutral-emotion condition, though neither simple effect was significant.

Approaching the 3-way interaction differently, we conducted separate 2 (Emotion) $\times$ 2 (Perspective) mixed ANOVAs on consistent and inconsistent trials. Recall that anxiety-impaired perspective calculation could also be revealed by higher processing costs on consistent trials where there is no perspective conflict to resolve. Analyses on the consistent trials revealed only a Perspective main effect, $F(1, 145)=6.37$, $p=.013$, $\eta_p^2=.04$, indicating that processing costs were higher on self trials versus other trials. This effect, which replicates prior work (Ramsey et al., 2010; Samson et al., 2010), may reflect the salience of the avatar, whose appearance in the visual scene may have eased processing of his perspective. Neither the Emotion main effect nor the Emotion $\times$ Perspective interaction was significant ($F_s < 1.02$), indicating that anxiety's effects on processing costs were negligible when self and other perspectives were aligned. On inconsistent trials where self and other perspectives were in conflict, however, results revealed a Perspective main effect that was the opposite of that observed on consistent trials, $F(1, 145)=22.26$, $p<.001$, $\eta_p^2=.13$. Furthermore, a marginal Emotion $\times$ Perspective interaction, $F(1, 145)=3.50$, $p=.063$, $\eta_p^2=.02$, indicated that the pattern of higher processing costs on other trials versus self trials was greater for anxious participants than for neutral participants.

Experiment 2

Experiment 1 provided initial support for the perspective-calculation account by showing that anxiety had opposing effects on patterns of egocentric and altercentric intrusion. Because we compared anxiety with neutral feelings, however, it is possible that other negative emotions produce comparable effects on L1-VPT. Thus, in Experiment 2, we compared anxiety with another high-arousal, negative emotion: anger (Russell, 1980). We also tested whether anxiety's

effects on L1-VPT reflect processes that are specific to social cognition versus more domain-general cognitive processes (Heyes, 2014; Santiesteban et al., 2014). After undergoing an anxiety or anger induction, participants completed either the same L1-VPT task as before (Experiment 2a) or a structurally-identical task that was void of social content (Experiment 2b).

Method

Participants. Native English-speaking undergraduates (Experiment 2a: $N=118$; Experiment 2b: $N=218^4$) participated for course credit. Computer malfunctions resulted in data loss for 8 participants in Experiment 2a; we also excluded data from 4 participants in Experiment 2a and 17 participants in Experiment 2b with errors on $>30\%$ of trials in the L1-VPT task, leaving final samples of 106 (76 women, 30 men) in Experiment 2a and 201 (121 women, 79 men, 1 unreported) in Experiment 2b.

Procedure. Experiment 2a was identical to Experiment 1, except that we replaced the neutral-emotion condition with an *anger* condition. Participants described a time when they felt very anxious or very angry (instructions adapted from Cataldo & Cohen, 2015).

Experiment 2b was identical to Experiment 2a, except that we replaced the human avatar with a non-social entity (i.e., a dual-colored stick; Surtees & Apperly, 2012) in the L1-VPT task. On *other* trials, participants verified if the number of dots on the yellow side of the stick matched or mismatched the given number. On *self* trials, participants verified if the number of dots they could see matched or mismatched the given number, as before.

After the L1-VPT task, participants completed emotion ratings. We averaged the anxiety (Experiment 2a: $\alpha=.91$, Experiment 2b: $\alpha=.88$), anger (*angry*, *annoyed*, *irritated*; Experiment 2a: $\alpha=.92$, Experiment 2b: $\alpha=.91$), and neutral (Experiment 2a: $\alpha=.77$, Experiment 2b: $\alpha=.77$) items.

⁴To increase the interpretability of potential null effects involving emotion, we used a substantially larger sample in Experiment 2b.

Results

Manipulation checks. In both experiments, experienced anxiety was higher, whereas experienced anger was lower, in the anxiety versus the anger condition ($ps < .001$, $gs > 0.84$). Unexpectedly, neutral feelings were slightly higher in the anger versus the anxiety condition in Experiment 2a ($p = .069$, $g = 0.35$) and Experiment 2b ($p = .042$, $g = 0.29$). However, participants in the anxiety condition reported greater anxiety than anger and neutral feelings, whereas those in the anger condition reported greater anger than anxiety and neutral feelings ($ps < .001$, $gs > 0.84$).

L1-VPT. Data were prepared as in Experiment 1. We report results separately for Experiments 2a and 2b, followed by a cross-experiment comparison.

Experiment 2a. A 2 (Emotion) $\times$ 2 (Perspective) $\times$ 2 (Consistency) mixed ANOVA in the social task (i.e., avatar) yielded main effects of Perspective (other > self), $F(1, 104) = 7.95$, $p = .006$, $\eta_p^2 = .07$, and Consistency (inconsistent > consistent), $F(1, 104) = 191.46$, $p < .001$, $\eta_p^2 = .65$. A Perspective $\times$ Consistency interaction, $F(1, 104) = 40.48$, $p < .001$, $\eta_p^2 = .28$, further indicated that, as in Experiment 1 and in prior work (e.g., Ramsey et al., 2013; Samson et al., 2010; Surtees et al., 2016), egocentric intrusion was stronger than altercentric intrusion.

Contrary to the *perspective-selection* account, the Emotion $\times$ Consistency interaction was not significant ($F < 1$). However, a marginally significant Emotion $\times$ Perspective interaction, $F(1, 104) = 3.42$, $p = .067$, $\eta_p^2 = .03$, indicated that the difference in processing costs on other trials versus self trials (other > self) was greater in the anxiety condition than in the anger condition. In line with the *perspective-calculation* account, moreover, the 3-way interaction was significant, $F(1, 104) = 6.05$, $p = .016$, $\eta_p^2 = .06$. Inspection of the Perspective $\times$ Consistency interaction within each emotion condition revealed that it was considerably larger for anxious participants, $F(1, 53) = 44.50$, $p < .001$, $\eta_p^2 = .46$, than for angry participants, $F(1, 51) = 6.72$, $p = .012$, $\eta_p^2 = .12$.

Figure 3. Processing costs for egocentric intrusion and altercentric intrusion by emotion condition for the social (avatar) and non-social (stick) tasks; error bars depict $\pm SEM$ (Experiments 2a and 2b).

To further specify the 3-way interaction in terms of our hypotheses, we calculated indices of egocentric intrusion and altercentric intrusion as in Experiment 1. As shown in Figure 3, egocentric intrusion was directionally stronger, $t(104)=1.40$, $p=.164$, $g=0.27$, whereas altercentric intrusion was directionally weaker, in the anxiety versus the anger condition, $t(104)=1.33$, $p=.188$, $g=0.26$, though neither simple effect was significant.

Approaching the 3-way interaction differently, we again conducted separate 2 (Emotion) $\times$ 2 (Perspective) mixed ANOVAs on consistent and inconsistent trials. Analyses on the consistent trials (i.e., perspectives aligned) revealed only a Perspective main effect, $F(1, 104)=15.13$, $p<.001$, $\eta_p^2=.04$. As in Experiment 1 and in prior work (e.g., Ramsey et al., 2013; Samson et al., 2010), processing costs were higher on self trials versus other trials. Also as in Experiment 1, neither the Emotion main effect nor the Emotion $\times$ Perspective interaction was significant ($F_s<1$), indicating that anxiety had little influence on processing costs when there was

no perspective conflict to resolve. On inconsistent trials (i.e., perspectives in conflict), however, results revealed a Perspective main effect that was the opposite of that on consistent trials, $F(1, 104)=23.56, p<.001, \eta_p^2=.19$. Furthermore, a significant Emotion $\times$ Perspective interaction, $F(1, 104)=5.34, p=.023, \eta_p^2=.05$, indicated that, as in Experiment 1, the pattern of higher processing costs on other trials versus self trials was greater for anxious versus angry participants.

Experiment 2b. An identical $2 \times 2 \times 2$ mixed ANOVA in the non-social task (i.e., stick) revealed main effects of Perspective (other>self), $F(1, 199)=15.10, p<.001, \eta_p^2=.07$, and Consistency (inconsistent>consistent), $F(1, 199)=258.28, p<.001, \eta_p^2=.57$, and a Perspective $\times$ Consistency interaction (egocentric intrusion>altercentric intrusion), $F(1, 199)=61.01, p<.001, \eta_p^2=.37$. However, neither the Emotion $\times$ Consistency interaction, the Emotion $\times$ Perspective interaction, nor the 3-way interaction was significant ($F_s<1.02$), suggesting that anxiety's effects on L1-VPT were confined to the social task involving a human agent.

Cross-experiment comparison. Combining data from both experiments provided additional evidence that anxiety's effects on L1-VPT appear to be socially-specific. Although both experiments were administered in the same laboratory, during the same semester, by the same experimenters, and using participants from the same population, because participants were not randomly assigned to experiment, these analyses should be interpreted cautiously.

A 2 (Task Version) $\times 2$ (Emotion) $\times 2$ (Perspective) $\times 2$ (Consistency) mixed ANOVA on processing costs yielded main effects of Perspective (other>self), $F(1, 303)=17.66, p<.001, \eta_p^2=.06$, and Consistency (inconsistent>consistent), $F(1, 303)=417.77, p<.001, \eta_p^2=.58$. There was also a significant Perspective $\times$ Consistency interaction, $F(1, 303)=127.75, p<.001, \eta_p^2=.30$; however, the pattern of means differed for the social and non-social tasks, as indicated by a Task Version $\times$ Perspective $\times$ Consistency interaction, $F(1, 303)=10.60, p=.001, \eta_p^2=.03$. Altercentric

intrusion was stronger in the social versus the non-social task, whereas egocentric intrusion was comparable across tasks, a pattern of results that replicates prior work (Nielsen et al., 2015; see also Furlanetto et al., 2016).

More important for the current research, there was a significant 4-way interaction, $F(1, 303)=4.26, p=.040, \eta_p^2=.01$. To further specify this interaction in terms of our hypotheses, we again calculated indices of egocentric and altercentric intrusion. A 2 (Task Version) $\times$ 2 (Emotion) between-subjects ANOVA on these indices revealed that the difference between the anxiety and anger conditions on altercentric intrusion was marginally stronger in the social versus the non-social task, $F(1, 303)=3.52, p=.062, \eta_p^2=.01$ (see Figure 3). The difference between the anxiety and anger conditions on egocentric intrusion was also directionally stronger in the social versus the non-social task, though this difference was not significant ($F<1$).

Discussion

We used Samson et al.'s (2010) L1-VPT task to test different predictions about anxiety's effects on cognitive processes underlying perspective taking. Results from three experiments with two comparison emotions (i.e., anger and neutral feelings) favored the perspective-calculation over the perspective-selection account. Support for the perspective-calculation account was conveyed by 3-way interactions indicating that anxiety had opposing effects on egocentric intrusion and altercentric intrusion in Experiments 1 and 2a. To provide more precise (and higher-powered) estimates of the simple effect of anxiety on egocentric and altercentric intrusion, we conducted an internal meta-analysis (Borenstein et al., 2009). Replicating prior research linking anxiety to egocentric biases in explicit mentalizing (Todd et al., 2015), anxiety increased egocentric intrusion, albeit only marginally ($g=0.22, 90\% \text{ CI: } [0.02, 0.43], Z=1.77, p=.077, \text{ two-tailed}$). More important for the current work, anxiety *decreased* altercentric

intrusion ($g=-0.26$, 95% CI: $[-0.01, -0.50]$, $Z=2.06$, $p=.040$, two-tailed). These meta-analytic results lend additional support to the perspective-calculation account, according to which anxiety impairs perspective taking, in part, by reducing spontaneous tendencies to track what others see.

The literature on anxiety is replete with examples of its adverse effects on cognitive performance in a variety of settings (Eysenck et al., 2007; Maloney et al., 2014). Our findings add to this literature by showing that anxiety's disruptive effects may be particularly pronounced for *social* aspects of cognition. Specifically, in Experiment 2, anxiety hindered spontaneous perspective calculation only when the target was a human avatar; no such effects emerged when replacing the avatar with a non-social entity (i.e., a dual-colored stick). These findings also enhance our current understanding of altercentric intrusion during L1-VPT. Despite claims that altercentric intrusion is driven by domain-general cognitive processes (e.g., directional shifts in attention) that are not specific to mentalizing (Heyes, 2014; Santiesteban et al., 2014), recent evidence suggests that altercentric intrusion cannot be accounted for by a simple form of directional cueing (Baker et al., 2016; Bukowski et al., 2015; Furlanetto et al., 2016) or basic perceptual processes (e.g., subitization, Baker et al., 2016). Our results complement these and other findings suggesting that altercentric intrusion is stronger for social versus non-social entities (Nielsen et al., 2015; Surtees & Apperly, 2012), and thus comport with claims that altercentric intrusion likely reflects implicit processing of others' *mental states*. Nevertheless, future research using more complex visual scenes that control for basic cognitive and perceptual processes or that introduce competing attentional cues (e.g., an avatar who is looking in one direction but pointing in the opposite direction) within a single task will help further clarify anxiety's effects on altercentric intrusion and potentially further elucidate the underlying nature of altercentric intrusion more generally.

The current research suggests multiple additional avenues for future research. We briefly mention two. First, our experiments examined anxiety's effects on spontaneous behavior displayed on an indirect measure of L1-VPT. Future research should explore whether similar findings emerge on indirect measures that assess the implicit tracking of higher-order mental states (e.g., beliefs; Kovács et al., 2010; Schneider et al., 2012). Future work might also investigate how anxiety shapes the dynamic processes by which the implicit tracking of what others see and know leads to more full-fledged judgments about such mental states (Apperly & Butterfill, 2009; De Bruin & Newen, 2012). Second, our focus here and in prior work (Todd et al., 2015) was on *incidental* experiences of anxiety triggered in an unrelated prior context. Future research should examine whether *integral* forms of anxiety (i.e., anxiety elicited by the specific perspective-taking target; Bodenhausen, 1993) also impedes perspective taking (see Bukowski & Samson, 2016, for work on integral anger versus guilt and L1-VPT).

Anxiety's often deleterious effects on intrapsychic aspects of cognition are well documented and understood (Eysenck et al., 2007). Much less is known, however, about how anxiety shapes *social* aspects of cognition, including processes involved in perspective taking. Extending previous findings that anxiety increases egocentrism when explicitly reasoning about others' mental states (Todd et al., 2015), the current work suggests that feeling anxious can also undermine spontaneous tendencies to track others' visual perspectives.

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