



Peering into the brain to predict behavior: Peer-reported, but not self-reported, conscientiousness links threat-related amygdala activity to future problem drinking

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ARTICLE INFO

Keywords:

Amygdala
Personality
Peer Reports
Conscientiousness
Problem drinking

ABSTRACT

Personality traits such as conscientiousness as self-reported by individuals can help predict a range of outcomes, from job performance to longevity. Asking others to rate the personality of their acquaintances often provides even better predictive power than using self-report. Here, we examine whether peer-reported personality can provide a better link between brain function, namely threat-related amygdala activity, and future health-related behavior, namely problem drinking, than self-reported personality. Using data from a sample of 377 young adult university students who were rated on five personality traits by peers, we find that higher threat-related amygdala activity to fearful facial expressions is associated with higher peer-reported, but not self-reported, conscientiousness. Moreover, higher peer-reported, but not self-reported, conscientiousness predicts lower future problem drinking more than one year later, an effect specific to men. Remarkably, relatively higher amygdala activity has an indirect effect on future drinking behavior in men, linked by peer-reported conscientiousness to lower future problem drinking. Our results provide initial evidence that the perceived conscientiousness of an individual by their peers uniquely reflects variability in a core neural mechanism supporting threat responsiveness. These novel patterns further suggest that incorporating peer-reported measures of personality into individual differences research can reveal novel predictive pathways of risk and protection for problem behaviors.

1. Introduction

Our peers' perceptions of us may provide unique insights into our mental health, personality, and even mortality. For example, Jackson *et al.* (2015) found that friend-reported personality traits were generally a better predictor of mortality than self-reported personality traits. Specifically, when controlling for self-reported personality traits, lower friend-reported conscientiousness and openness predicted higher mortality risk in men while lower friend-reported agreeableness and emotional stability predicted higher mortality in women. Informant reports more broadly have been shown to be useful predictors across a range of other outcomes, including academic achievement (Connelly and Ones, 2010; Kurtz *et al.*, 2012), physical health in adulthood (Israel *et al.*, 2014), job performance (Oh *et al.*, 2011), clinical severity of psychopathology (Verhulst and van der Ende, 1991), and the future emergence of depressive symptoms (Ronning *et al.*, 2011), often predicting additional variance in these outcomes above and beyond self-report. While the nature of such predictive associations is unclear, it has been hypothesized that informant reports may overcome certain

biases present in self-report data, and that when multiple informant reports are obtained, averaging across informants increases the reliability of measurements (Jackson *et al.*, 2015; Oh *et al.*, 2011; Vazire and Mehl, 2008). In this way, it is possible that peer-reports of trait-like personality may also better reflect biological features of an individual than self-report.

In the context of behavioral neuroscience, we often consider associations between individual measures of brain function and self-reported personality or behavior (Hariri, 2009). Peer reports may offer a unique window onto the behavioral correlates of brain function from observers who are familiar with an individual across different contexts and can make judgments based on observations of behavior aggregated over time. Thus, peer reports may map onto inter-individual variability in behaviorally- and clinically-relevant brain function not captured through self-report. As such, peer reports may help us identify previously undetected links between brain function and personality that can subsequently inform relative risk for psychopathology or even optimize treatment strategies (Flory *et al.*, 2002; Kotov *et al.*, 2010; Naragon-Gainey and Watson, 2014; Ronning *et al.*, 2011; Verhulst and

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van der Ende, 1991; Wardenaar et al., 2014).

The goal of the present work was to examine whether variability in behaviorally- and clinically-relevant brain function, namely threat-related amygdala activity assessed using BOLD fMRI, is associated with peer-reported personality traits including extraversion, conscientiousness, neuroticism, openness, and agreeableness, above and beyond self-reported personality. We further planned to test whether these associations were useful for predicting clinically-relevant behavioral outcomes by testing whether peer-reported personality traits predicted future problem drinking above and beyond self-reported personality traits. We focused our analyses on threat-related amygdala activity because this neural phenotype has been extensively examined in relation to self-reported behaviorally- and clinically-relevant outcomes in this (Nikolova et al., 2016; Swartz et al., 2015; Swartz et al., 2016) and other samples (Glahn et al., 2007; Marinkovic et al., 2009). In particular, in the present sample, we have found that higher threat-related amygdala activity moderates the experience of stress-related problem drinking associated with reward-related brain function (Nikolova et al., 2016). Furthermore, peer reports of personality specifically were chosen for our analyses because our sample of young adult full-time university students spends a relatively large proportion of time socializing with friends, and thus peers may have more opportunities to observe their behaviors across multiple contexts than other potential informants such as instructors or parents (Eagan et al., 2014). For each participant, we used personality ratings from one to two peers as well as their own self-reported personality.

Our prior work in this sample has demonstrated that individuals with higher threat-related amygdala activity have lower levels of self-reported extraversion (Swartz et al., 2016), as well as higher levels of mood and anxiety symptoms under stress (Swartz et al., 2015). Prior research in other samples has also indicated a positive association between amygdala activity and self-reported neuroticism (Chan et al., 2009; Everaerd et al., 2015; Haas et al., 2007). We therefore hypothesized that higher threat-related amygdala activity would be associated with lower peer-reported extraversion but higher peer-reported neuroticism. We did not form directional hypotheses regarding the other personality traits examined given the lack of research in this area to date. Prior research on the personality correlates of problem drinking behavior with both self- and informant-rated personality has indicated that higher extraversion and neuroticism and lower conscientiousness and agreeableness are associated with problem drinking or alcohol use disorders (Flory et al., 2002; Hampson et al., 2006; Malouff et al., 2007). Thus, we further hypothesized that peer-reported personality would predict future problem drinking in a similar direction, and that it would explain additional variance above and beyond self-reported personality (Connelly and Ones, 2010; Jackson et al., 2015).

2. Materials and methods

2.1. Participants

Of the 1202 participants recruited as part of the ongoing Duke Neurogenetics Study (DNS) as of June, 2015, participants for the present study included 418 young adult university students who had informant data from at least one peer. All procedures were approved by the Duke University Medical Center and participants provided informed consent before study initiation. Participants were college-aged ($M=19.8$ years, $SD=1.3$, range: 18 to 22) and 61% were female. Within the current sample, 48% were Caucasian, 32% were Asian, 9% were African American, 7% were bi- or multi-racial, .5% were Native American, and 3.5% self-reported as other. Diagnosis of any past or current DSM-IV Axis I disorder or select Axis II disorders (antisocial personality disorder and borderline personality disorder), assessed with the electronic Mini International Neuropsychiatric Interview (Sheehan et al., 1998) and Structured Clinical Interview for the

DSM-IV subtests (First et al., 1996) was not an exclusion. Within the current sample, 67 participants (16%) had at least one past or current psychiatric diagnosis. The most frequent past and current diagnoses were as follows: 35 with alcohol use disorder, 11 with a non-alcoholic substance use disorder, and 18 with major depressive disorder (these include comorbid diagnoses).

As part of the DNS protocol, participants were asked to nominate 3 individuals that knew them well to complete informant reports. Nominated individuals were contacted by e-mail and sent a link to complete the informant questionnaire online. As part of the questionnaire, informants self-selected belonging to one of the following categories: parent, sibling, other relative, close friend, spouse/partner, employer, or other. For the purposes of the present study, we defined a peer as any informant who self-identified as a close friend and who was within 4 years of age to the participant. Peer informants were generally college-aged ($M=19.9$, $SD=1.4$, range: 16 to 25 years), 66% were female, and, on a scale from 1 (Not very well) to 3 (Very well), reported knowing the participants very well ($M=2.82$, $SD=0.4$). Analyses leveraged personality reports from 1–2 peers for each participant ($M=1.30$) as relatively few participants had all 3 reports completed by friends (5%). Of the 418 participants with peer-report data, 377 had imaging data meeting quality control criteria (see fMRI methods below). Participant characteristics for this final sample are reported in Table 1.

2.2. Functional neuroimaging

Participants were scanned using a research-dedicated GE MR750 3T scanner at the Duke-UNC Brain Imaging and Analysis Center. Amygdala activity to threat was assessed using an emotional face matching paradigm described in detail in previous research (Nikolova et al., 2016; Swartz et al., 2015, 2016). The paradigm version used in

Table 1
Participant characteristics.

	Mean (SD)	Min	Max
Participant age	19.8 (1.3)	18	22
Informant familiarity	2.8 (0.4)	1.5	3.0
Number of peer informants	1.3 (0.5)	1	2
Self: extraversion	119.5 (19.8)	65	173
Self: conscientiousness	118.3 (22.1)	22	168
Self: neuroticism	86.1 (23.7)	34	169
Self: agreeableness	118.0 (18.5)	61	163
Self: openness	125.3 (17.8)	67	174
Peer: extraversion	11.9 (2.2)	5	15
Peer: conscientiousness	12.0 (2.1)	6	15
Peer: neuroticism	8.3 (2.3)	5	15
Peer: agreeableness	12.8 (1.8)	7	15
Peer: openness	12.0 (1.9)	6	15
Problem drinking (Baseline)	5.3 (4.2)	0	21
Problem drinking (Follow-up)	4.5 (3.8)	0	22
Participant sex (% female)	59%		
Past or present psychiatric diagnosis	17%		
Caucasian	47%		
Asian	33%		
African American	8%		
Bi-racial or multi-racial	7.7%		
Native American	.3%		
Other race/ethnicity	4%		

Note: Informant familiarity was assessed by asking how well peer informants knew the participant on a 3-point scale; self-reported personality was measured with the NEO Personality Inventory Revised; peer-reported personality was measured with an informant-report measure adapted from the Dunedin Multidisciplinary Health and Development Study (Israel et al., 2014); problem drinking was measured with the Alcohol Use Disorders Identification Test; past or present psychiatric diagnosis indicates the percentage of participants with at least one past or present DSM-IV diagnosis as assessed by the electronic Mini International Neuropsychiatric Interview. Participant characteristics are presented for the 377 participants with both peer-report and fMRI data.

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