Median- and Robust Statistics-based Attention Indices Outperform Mean-based Counterparts in Predicting Anxiety

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Introduction

- Attention control, or goal-directed attention allocation, maintenance, and shifting (Keller et al., 2019; Miyake et al., 2000) is integral to adaptive functioning and is impaired among those prone to anxiety disorders, particularly when in dysphoric states (Keller et al., 2019; Koster et al., 2011).
- Visual attention-based paradigms have gained considerable interest as measures of attentional control, with eye-tracking paradigms in particular showing promise to reduce measurement error associated with motor speed and having more favorable psychometric properties than behavioral alternatives (e.g., dot-probe tasks; Dear et al., 2011; Waechter & Stolz, 2015).
- Eye-tracking based attention control tasks frequently prompt respondents to make a key-press in response to a visual cue under neutral and emotionally valenced conditions while covertly measuring time-to-first-fixation on the target cue across multiple trials (e.g., Sanchez et al., 2013).
- The resulting attention control indices reflect mean fixation delays. Yet, means are highly susceptible to the presence of outlying observations that frequently fall within the valid range of responding.
- Median and median-informed robust mean estimators are well-known to attenuate the influence of outlying values but are rarely employed in eye-tracking paradigms.
- Therefore, this study investigated the predictive validity of arithmetic mean, median, and robust-mean-based eye-tracking attention shifting away from sad and happy valenced faces towards neutrally valanced faces that have been previously been shown to predict anxiety symptoms.

Hypotheses

H1: Slow visual attention disengagement from sad-valenced and rapid disengagement from happy-valenced faces will predict elevated anxiety symptoms.

H2: Median- and robust-mean-based disengagement indices will evidence stronger associations described in H1 than will arithmetic-mean based indices.

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Table 1. Descriptive statistics and bivariate correlation of study variables (N=147)

Variables	*M* (*SD*)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Age	26.85 (12.02)	--									
2. Sex	---	-.08	--								
3. SIAS	27.50 (16.11)	-.13	-.15	--							
4. PSWQ	35.23 (17.66)	-.06	-.37***	.64***	--						
5. S.Dis-*M*	266.15 (123.14)	.26***	-.08	.08	.05	--					
6. S.Dis-*Mdn*	254.34 (109.81)	.24**	-.04	.06	.03	.94***	--				
7. S.Dis-*RM*	257.14 (115.85)	.25**	-.06	.08	.02	.96***	.99***	--			
8. H.Dis-*M*	286.92 (202.31)	.16	-.12	.00	.02	.27***	.24***	.26***	--		
9. H.Dis-*Mdn*	248.80 (52.25)	.30***	.20*	-.06	.01	.55***	.52***	.53***	.40***	--	
10. H.Dis-*RM*	253.84 (66.14)	.34***	-.13	-.07	-.08	.53***	.46***	.52***	.43***	.83***	--

Note. Sex = (0=female, 1=male), SIAS = Social Interaction Anxiety Scale, PSWQ = Penn State Worry Questionnaire, S.DIS = time-to-first fixation on neutral face from sad face, H.Dis = time-to-first fixation on neutral face from happy face, *M* = arithmetic mean, *Mdn* = median, *RM* = Tukey's bisquare-based robust mean.
***$p < .001$, **$p < .01$, *$p < .05$

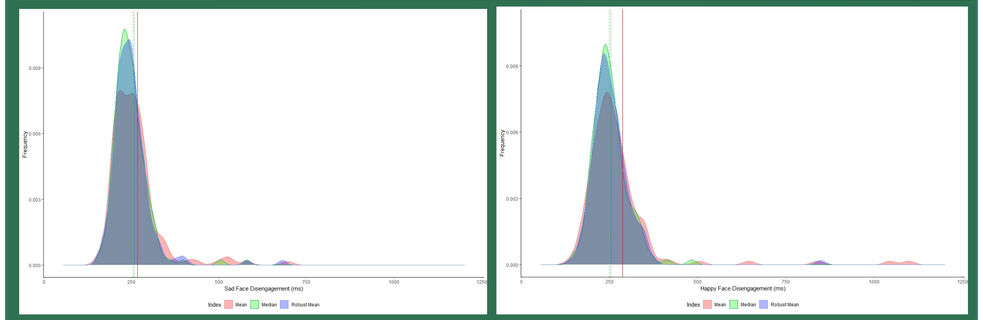

Figure 2. Sad face (left) and Happy face (right) Mean, Median, and Robust Mean disengagement index Kernel Density Plots.

Table 2. Generalized Linear Models predicting Social Anxiety and Worry levels from Mean-, Median-, and Robust-Mean based Attention Disengagement Indices and Covariates (N=147).

	SIAS						PSWQ					
	Mean		Median		Robust Mean		Mean		Median		Robust Mean	
Predictor	*b*	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*
1. Age	-.210	.110	-.170	.116	-.174	.117	-.132	.111	-.111	.113	-.080	.112
2. Sex	-6.077*	2.991	-7.092*	2.861	-6.523*	2.875	-15.364***	3.028	-15.969***	2.918	-16.068***	2.914
3. S.Dis	.015	.008	.024**	.008	.023**	.008	.007	.009	.011	.009	.016*	.006
4. H.Dis	-.002	.003	-.046	.031	-.033	.024	-.002	.006	-.027	.033	-.045**	.016

Note. Sex = (0=female, 1=male), SIAS = Social Interaction Anxiety Scale, PSWQ = Penn State Worry Questionnaire, S.DIS = time-to-first fixation on neutral face from sad face, H.Dis = time-to-first fixation on neutral face from happy face.
***$p < .001$, **$p < .01$, *$p < .05$

Method

- Participants & Procedures
  - N= 148 adults (75% female, M = 27.08 years old, SD = 12.30) completed survey measures and a visual attention control task (Sanches et al., 2013) via E-prime 3.0 and the Tobii X3-120 eye-tracking system.
- Measures
  - The Social Interaction Anxiety Scale (SIAS, Mattick and Clarke, 1998)
  - The Penn State Worry Questionnaire (PSWQ, Meyer et al., 1990)
- Eye-tracking Attention Control Task
  - Following a fixation cross and a random single digit that was read allowed, participants viewed neutral-valenced forward-facing, same-actor image pairs, that were followed by gaze-contingent cues (circle or square); time-to-first fixation towards the neutral face indexed sad and happy face disengagement (see Figure 1).

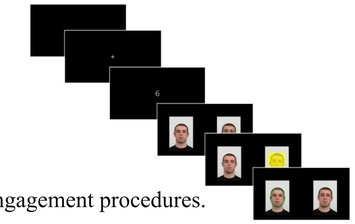

Figure 1. Attention disengagement procedures.

- Generalized Linear Models that covaried age and biological sex effects tested the predictive value of arithmetic mean, median, and Tukey's bisquare-based robust mean sad and happy face attentional disengagement.`

Results

- Sad-valenced face disengagement indices were highly intercorrelated, in contrast to happy-valenced face indices for which strong associations were evident among median and robust variants (see Table1), a pattern likely due to outliers' presence in the latter index (see Figure 2). Bivariate correlations between anxiety measures and disengagement indices were non-significant.
- Positive intercorrelations among the disengagement indices suggests the presence of a common factor, such as general attention shifting, or common method variance.
- H1. In partial support, slow attentional disengagement from sad-valenced faces predicted elevated social anxiety and worry levels, as did rapid disengagement from happy-valenced faces when predicting worry levels. However, the significance of these effects varied as a function of the index computation (see Table 2)
- H2. As hypothesized, robust-mean based indices outperformed their arithmetic-mean-based counterparts in predicting anxiety symptoms, as did median-based indices to a lesser extent (see Table 2).

Conclusion

- Findings support the utility of quantifying attention processes via robust statistical approaches that attenuate outlier influence and highlight the need to take into account shared method (or trait) variance when examining unique effects of eye-tracking based valenced attention disengagement indices.