Journal of Research in Personality 113 (2024) 104538

Contents lists available at ScienceDirect

Journal of Research in Personality

journal homepage: www.elsevier.com/locate/jrp

Full Length Article

Looking through a glass onion: Exploring the validity of eye-tracking technology in capturing self-directed attention

Jean Monéger[a,b,*], Nicolas Noiret[c]

[a] Université de Reims Champagne-Ardenne, France
[b] Université Paris Cité, France
[c] Université de Poitiers, Université de Tours, CNRS, CeRCA, Poitiers, France

ARTICLE INFO

Keywords:
Eye-tracker
Self-directed attention
Self-consciousness
Personality
Psychometrics

ABSTRACT

Self-directed attention is a central aspect in most psychological models in the clinical, social and personality literature. However, precise measures of self-directed attention are lacking. Building on recent methodological developments, the present study (N=104) provides an exploratory assessment of the Incidental Mirror Exposure (I-ME) paradigm combining reflective screens with eye-tracking devices to measure self-directed attention. Personality traits associated with self-directed attention were assessed to evaluate the theoretical validity of basic oculometric measures. We additionally suggest a novel measure of self-focus integrating time spent looking at the self-reflecting area of the screen and depth of the gaze looking through the screen. Results underline the relevance of eye-tracking paradigms to capture maladaptive self-directed attention such as social anxiety, vulnerable narcissism, and self-absorption.

1. Introduction

Directing one's attention toward the self is an essential feature of goal pursuit according to cybernetic models of self-regulation (Carver & Scheier, 1981). However, to the extent that self-directed attention is associated to a process of self-evaluation, entailing self-to-standards comparisons (Duval & Wicklund, 1972), it is often assumed to be an aversive activity that one would avoid – especially in failure situations (Hull & Young, 1983; Landrault et al., 2020; Monéger et al., 2022, 2023; Pyszczynski & Greenberg, 1985). In this paper, 'self-directed attention' refers to the process of orienting, selecting and/or processing information related to oneself. How to accurately measure attention toward the self? Self-report scales, and notably the widely used self-consciousness scale (Fenigstein et al., 1975), offer the possibility to assess self-consciousness, a personality trait defined as the proneness to direct one's attention toward the self. However, as an attentional process, self-directed attention differs from – although conceptually overlaps with – self-consciousness. Self-reported scales, in addition to being direct and controllable (eliciting responses motivated by social demands and social desirability), assess stable traits rather than an actual behaviour of directing one's attention toward the self. Because completing scales about oneself requires self-directed attention, it is fundamentally impossible to use them to measure a state resulting from self-directed attention.

Some studies used experimental situations enabling a behavioural measure of one's aversion/preference in self-directed attention (Arndt et al., 1998; Lipson et al., 1983; Twenge et al., 2003, study 6). However, those measures tack the avoidance of self-directed attention by either posing a self-aware vs. not self-aware choice, or assessing time spent doing an activity in front of a mirror, rather than an actual attentional process.

Modern technological advances might offer new possibilities in measuring self-directed attention. In particular, eye-trackers are widely used to investigate visual attention orientation and focusing to salient elements in the environment (e.g., Armstrong & Olatunji, 2012; Chita-Tegmark, 2016), including visual information related to the self. For instance, some studies examined self-directed attention by recording eye movements while participants viewed photographs of themselves (Bauer et al., 2017; Bortolon et al., 2016) or chatted during videocalls (Ariss et al., 2023; Lin et al., 2021; Vriends et al., 2017), but the explicit presence of one's image while tracking gaze behaviors could make these paradigms explicit. Potthoff and Schienle (2021) used a mirror fixated to a screen to assess self-directed attention while recording participants' eye movements. However, this paradigm also lacks discretion and

* Corresponding author at: Université de Reims Champagne-Ardenne, France.
E-mail address: moneger.jean@outlook.fr (J. Monéger).

https://doi.org/10.1016/j.jrp.2024.104538
Received 5 June 2024; Received in revised form 24 August 2024; Accepted 3 September 2024
Available online 5 September 2024

participants are forced to explicitly (i.e., directly) direct their attention toward themselves. In order to solve this problem, Monéger et al. (2022) asked participants to perform a lexical decision task with target words appearing on each corner of a reflective dark screen wherein the participant could see themselves. They measured the number of saccadic eye movements made from outside the region of the screen reflecting the face toward the region of the screen reflecting the face and observed evidence for self-avoidance in failure situation interacting with guilt-proneness. Although this study suggests new possibilities of evaluating self-directed attention, the theoretical validity of this paradigm have yet to be critically examined.

In the current article, we report a preliminary investigation of the theoretical validity of the Incidental Mirror Exposure (I-ME) paradigm suggested by Monéger et al. (2022). The study was guided by the following questions:

(1) Does the I-ME paradigm can capture self-directed attention efficiently. If so, gaze behaviours using this paradigm should be predicted by the disposition to direct one's attention toward the self (i.e., self-consciousness).

(2) Is the type of attentional process assessed in the I-ME paradigm related to specific types of personality? Drawing on the fact that self-directed attention can indicate both healthy (i.e., high self-esteem, grandiose narcissism) and unhealthy (self-absorption, depression, vulnerable narcissism) dispositions, we evaluated which personality traits was the most important contributor in explaining self-directed gaze behaviors using the I-ME paradigm. Selected personality traits and rationale for their inclusion are described in Table 1.

Finally, the current study offers a finer-grained measure of self-directed attention addressing the shortcomings of basic measures of self-directed attention reported in the literature. In particular, although time spent on the self might be the most straightforward computation of self-directed attention (see Lin et al., 2021; Potthoff & Schienle, 2021; Vriends et al., 2017), it could fail to capture self-focus and could be indicative of a general strategy in the context of the I-ME paradigm (i.e., focusing on the central part of the screen results in an optimal distance to the future targets regardless of their location). To obtain a more precise account of self-directed attention, it might be necessary to consider the interplay between time spent looking at the self, and the depth at which one is looking. Indeed, one could spend time on the part of the screen reflecting one's face (increased time spent looking at the centre of the screen indicating increased self-directed attention) without actively looking at their reflection through the reflective screen. Conversely, one could display in-depth gazing at their reflection through the screen but actively avoid spending too much time on this part of the screen (decreased time spent looking at the centre of the screen indicating reduced self-directed attention). It follows that time spent looking at the centre of the screen is indicative of self-directed attention only to the extent that one is actively gazing toward their self-image (i.e., behind the computer screen). Ocular vergence, the angle formed by each eye's gaze, indicates the distance separating the individuals from the point they are looking at (Erkelens et al., 1997; Wann et al., 1995; see also Supplementary Material).

We thus evaluated the effect of personality traits on self-focus, defined in the present study as the association between dwell time (i.e., time spent on the area of the screen reflecting the self) and ocular vergence (i.e., depth of the visual focus point beyond the reflective screen). Personality traits fostering greater self-directed attention should increase self-focus such that smaller angle of vergence (indicating gazing through the screen) should be associated to longer time spent looking at the self. In contrast, personality traits buffering self-directed attention should reduce this relationship such that smaller angle of vergence should either be unrelated to or predict shorter time spent looking at the self.

2. Methods

2.1. Disclosure statement

We report all data exclusions, all manipulations, and all measures in the study. The study was evaluated by the ethical committee of the universities of Tours and Poitiers (CER-TP n°2022-12-04). Codes and material are available at the OSF webpage of the project (https://osf.io/kw7up/).

2.2. Participants

Inclusion criteria required participants to have normal or corrected-to-normal (using glasses or contact lenses) vision. Wearing rigid contact lenses was specified as an exclusion criterion as it is difficult to accurately calibrate individuals wearing those. Participants were 104 first year psychology undergraduates from a medium sized French university ($M_{age} = 19.02$, $SD_{age} = 1.82$, with 82 women, 18 men, 1 non-binary, and 3 unrecorded). They participated in the study in exchange for course credit. Statistical power was limited by the available resources. However, a sensitivity analysis indicated 80 % chance of detecting a correlation of $r = 0.27$.

2.3. Materials

I-ME paradigm. We used the I-ME paradigm reported by Monéger et al. (2022) to capture self-directed attention. We used a Plexiglas covered screen (versus a reflexive iMac screen in the original study). The reflective properties of a Plexiglas covered screen are better than the one of the iMac (i.e., closer to a clean mirror reflection). An Eye-Link portable Duo (SR Research) was used with a sampling frequency of 500 Hz. Saccades were selected using instantaneous velocity and acceleration thresholds of 30°/s and 8000°/s, respectively. Samples above threshold are determined to be in saccade, and samples below threshold are determined to be in fixation. The screen used was a 1920 x 1080 pixels screen with a refresh rate of 60 Hz. Participants head was placed in chinrest with eyes at 720 mm from the upper part of the screen and 750 mm from the bottom part of the screen. We measured ocular activity from their both eyes throughout the session. The periods of interest were the intertrial periods separating a decision from the participant and the apparition of the next target. During these periods, the screen was a blank reflective screen that the participant could freely scan while expecting the target to appear in one of the four corners of the screen at any moment. At the end of the protocol, participants were instructed to stare at their reflection in the screen and slowly gaze at the contour of their self-reflected face. We used this contour task to define individual area of interest (AOI) corresponding to the part of the screen reflecting each screen. We then drew an oval AOI encompassing each individual AOI located during the experiment (see SOM for more details on the procedure).

During the session, participants performed an unrelated lexical decision task: strings of letters were either words (e.g., TABLE) or non-words (e.g., TEBLA) and were randomly displayed in four possible locations of the screen (upper right, upper left, bottom right and bottom left corner of the screen). Target words were the same as the one used in Monéger et al. (2022). The shortest word (LA [*the*]) had a dimension of 1.11 x 1.43 degrees of visual angle° and the longest word (BONSOIR [Good evening]) had a dimension of 1.11 x 5.57 degrees of visual angle

Table 1
Pool of predictors included in the study.

Predictor	Measure	Description	Rationale
Private Self-consciousness	Self-Consciousness Scale (Fenigstein et al., 1975)	Proneness to direct one's thoughts toward thoughts and feelings.	By definition, this measure should predict self-directed attention.
Public Self-consciousness		Proneness to direct one's attention toward public aspects of the self	By definition, this measure should predict self-directed attention.
Social Anxiety		Proneness to feel negatively affected by observer's presence – a maladaptive facet of public self-consciousness	A prediction of this facet of self-consciousness would indicate that the I-ME is sensitive to a maladaptive aspect of self-consciousness
Self-Absorption	Self-Absorption Scale (McKenzie & Hoyle, 2008)	Inability to avoid directing one's attention toward the self – maladaptive self-consciousness	By definition, this facet should be associated with self-directed attention, especially if the I-ME paradigm is sensitive to maladaptive self-directed attention
Self-Esteem	Rosenberg Self-Esteem Scale (Rosenberg, 1965)	Attitude toward the self	Individuals with low self-esteem should avoid self-directed attention (Brockner & Wallnau, 1981; Sedikides, 1992).
Vulnerable Narcissism	Hypersensitive Narcissism Scale (Hendin & Cheek, 1997)	Hypersensitive, defensive, insecure, introverted form of narcissism.	Despite being sometimes defined by increased levels of self-consciousness (Miller et al., 2021), vulnerable narcissism is defined by negative self-esteem, defensiveness, and heightened sensitivity to self-threats (Horvath & Morf, 2009; Jauk & Kanske, 2021). As such it might be associated to self avoidance.
Grandiose Narcissism	Narcissistic Personality Inventory (Raskin & Hall, 1979)	Grandiose, aggressive, dominant, extroverted form of narcissism	Grandiose narcissism is systematically associated to positive self-esteem, and excessive self-directed attention (Jauk & Kanske, 2021; Konrath et al., 2009; Scalabrini et al., 2017; Watson & Biderman, 1993).
Depression	Center of Epidemiology Scale – Depression (Radloff, 1977)	Symptoms of clinical depression	Depression has been consistently associated to heightened self-directed attention (see Mor & Winquist, 2002 for a *meta*-analysis).

(see SOM for list of words[1]). Participants were instructed to indicate as quickly as possible and with as few errors as possible whether the displayed target was a word by pressing a trigger on the right side of a controller (Microsoft SideWinder Controller) or a non-word by pressing a trigger on the left side of the controller. After each decision, the delay before the apparition of the next target was randomly chosen in a list of possible inter-trial intervals spanning from 325 ms (i.e., very short inter-trial time) to 8485 ms.[2] The aim of this protocol was to solicit the attention of the participant and motivate them to scan the screen, keeping them in a vigilant state throughout the study. Importantly, the experiment was introduced to the participants as a measure of ocular processes occurring during reading activities – at no point were the participants explicitly informed about the reflective screen (except during the final phase of AOI definition), thus making the measure indirect. We then derived 4 measures of self-directed attention with 3 of them regarded as basic oculometric measures (dwell time spent looking at the area of the screen reflecting the participant's face, saccades toward the area of the screen reflecting the participant's face, and ocular vergence indicating depth of visual focus toward the reflected participant's face) and one complex oculometric index (self-focus, corresponding to the association between time looking at the area of the screen reflecting the participant's face, and ocular vergence indicating depth of the gaze beyond the screen and toward the reflected face).

Dwell Time. Dwell time was extracted using the DataViewer program of SR Research. This score indicates the proportion of time spent (in %) supposedly looking at one self (or at least time spent being exposed to the possibility of looking at oneself) during the inter-trial interval.

Saccades toward the AOI. We designate as saccades toward the AOI any fixation captured in the AOI that was preceded by a fixation outside the AOI. Any fixation occurring after the target appeared was discounted. This score is indicative of glances toward one's self reflection.

Vergence. Ocular vergence corresponds to the angle (in degrees of angle) formed at the intersection of both eyes gaze vectors,[3] the intersection point being the point in space that is gazed by the participant. Thus, it changes as a direct function of the depth at which participants are staring on or through the screen: larger angles of vergence indicate a focal point closer to the eyes, whereas smaller angles of vergence indicate more distal focal points (see SOM for details on how angle of vergences indicate depth of vision). We discarded every measure of vergence occurring for locations outside the AOI to compute the average ocular vergence in the AOI during a trial. We then computed average vergence throughout the task. Vergences equalling zero (indicating that both eyes are positioned at the same location on one's head, or that participants are having perfectly parallel gaze vectors) and deviating plus or minus than 2.5 MAD from the median where discarded because they were likely artefacts.

Self-Focus. Finally, we assessed the effect of personality traits on the association between vergence and dwell time to define self-focus, as presented in introduction. To model self-focus, we conducted mixed model analyses, accounting from random variations stemming from the time available to look at the AOI and intra-participant variation. In independent models, we evaluated the moderating effect of personality traits on the effect of ocular vergence of dwell time. Increased self-focus should be indicated by increased dwell time as ocular vergence decreases (i.e., looking through the screen). Traits fostering self-focus should strengthen this negative relation (i.e., negative beta associated to the interaction), while traits buffering self-focus should reverse it (i.e., decreased dwell time as ocular vergence decreases, indicated by a positive beta in the interaction).

2.4. Personality measures

In order to assess the theoretical validity of this measure of self-directed attention, we assessed a plurality of constructs theoretically associated to a proneness to direct one's attention toward (vs away

[1] Possible words were: BONSOIR (*good evening*), TEMPS (*time*), LOI (*law*), Sable (*sand*), LIVRE (*book*), TABLE (*table*), SOIR (*evening*), VENT (*wind*), LAIT (*milk*), GRILLE (*grid*), COULOIR (*hallway*), TUILE (*tile*), PINCEAU (*paint brush*), SOUVENT (*often*), GRUE (*Crane*), TIROIR (*drawer*), FEUILLE (*leaf*), BOIS (*wood*), TOUCHE (*button*), ROND (*round*), MURET (*low wall*), PORTE (*door*), BEURRE (*butter*), SOL (*floor*), BANC (*bench*), TEMPS (*time*).

[2] Possible inter-trial durations were: 325 ms, 236 ms, 378 ms, 432 ms, 454 ms, 490 ms, 558 ms, 566 ms, 677 ms, 678 ms, 745 ms, 754 ms, 862 ms, 917 ms, 936 ms, 959 ms, 1040 ms, 1073 ms, 1117 ms, 1131 ms, 1194 ms, 1235 ms, 1256 ms, 1310 ms, 1399 ms, 1480 ms, 3197 ms, 3272 ms, 3277 ms, 3310 ms, 3404 ms, 4079 ms, 4237 ms, 4435 ms, 4639 ms, 5527 ms, 5756 ms, 6195 ms, 6245 ms, 6352 ms, 6452 ms, 6531 ms, 7178 ms, 7204 ms, 7281 ms, 7934 ms, 8480 ms, 8485 ms.

[3] We kindly thank SR research for providing a custom script to compute ocular vergence.

from) the self. These constructs were all measured using conventional self-reported measures, and are described in the following sections.

Self-Consciousness. Self-consciousness is defined as a stable disposition toward focusing on the self and is thus directly related to self-directed attention. This personality trait should theoretically be the strongest predictor of self-directed attention. As such, it is regarded as the standard predictor of gaze behaviours in the I-ME paradigm. It is assessed using the Self-consciousness scale (Fenigstein et al., 1975; translated to French by Pelletier & Vallerand, 1990), a scale with three sub-scales: private self-consciousness (e.g., "*I'm always trying to figure myself out*"), public self-consciousness (e.g., "*I usually worry about making a good impression*"), and social anxiety (e.g., "*It takes me time to overcome my shyness in new situations*"). Twenty-two Items composing the full scale were rated on a scale from 0 ("*Not at all like me*") to 5 ("*Completely like me*").

Self-Absorption. Self-absorption is often defined as the maladaptive form of self-consciousness. It is defined as "excessive, sustained, and rigid attention to information emanating from internal sources" (Ingram, 1990, p. 169). We used the Self Absorption test (McKenzie & Hoyle, 2008), a 17-items scale that was translated to French using a back-translation process, to measure self-absorption. Two subscales are present in the scale: private self-absorption (e.g., "*I think about myself more than anything else*") corresponding to excessive attention to private aspects of the self, and public self-absorption (e.g., "*I find myself wondering what others think of me even when I don't want to*") corresponding to excessive attention toward public aspects of the self. Items were rated on a scale from from 0 ("*Not at all like me*") to 5 ("*Completely like me*").

Self-Esteem. Trait self-esteem corresponds to the attitude one has toward the self. To the extent that self-focused state might elicit anxiety among low self-esteem individuals, these individuals might be more willing to avoid directing their attention toward the self (e.g., Brockner & Wallnau, 1981). In order to measure trait self-esteem, we used the estabilished 10-items Rosenberg Self esteem scale (Rosenberg, 1965; french version validated by Vallières & Vallerand, 1990). Items such as "*On the whole, I am satisfied with myself*" rated on a scale from 0 ("*Not at all like me*") to 5 ("*Completely like me*").

Depression. Self-focused attention is positively associated to depression (for a *meta*-analysis reporting medium to large correlations between self-focus and depression, see Mor & Winquist, 2002). We used the Center for Epidemiologic Studies-Depression Scale (French version validated in Morin et al., 2011) to measure depression scores. The scale is composed of 20 items ("*I did not feel like eating; my appetite was poor*") that participants have to evaluate using a 6 points scale from "*Never*" to "*Permanently*".

Grandiose Narcissism. Narcissism is described as a polyhedral concept comprising several forms of narcissistic expressions (Sedikides, 2021). The most studied form of narcissism being grandiose narcissism associated to "extraversion, boasting, dominance, manipulativeness" (Sedikides, 2021, Fig. 1). Self-focus has often been used as a characteristic of narcissism, for instance it is used in the description of narcissism provided in the Single Item Narcissism Scale (Konrath et al., 2014). Several studies provided evidence for positive correlations between grandiose narcissism and increased self-focus (Konrath et al., 2014; Raskin & Shaw, 1988; but see Carey et al., 2015). To assess grandiose narcissism, we used the 16 items version of the Narcissism Personality Inventory (French version, Braun et al., 2016), presenting 16 pairs of statements (e.g., "*I really like to be the center of attention*" vs "*It makes me uncomfortable to be the center of attention*") the participants have to choose from.

Vulnerable Narcissism. Another well-established form of narcissism is vulnerable narcissism, associated to "introversion, worry, defensiveness" (Sedikides, 2021, Fig. 1). This facet of narcissism is usually related to heightened sensitivity to self-threats (Besser & Priel, 2010; Jauk & Kanske, 2021) and as such should be associated to lowered self-focused attention. To assess this personality trait, we used the Hypersensitive Narcissistic Scale (HSNS; Hendin & Cheek, 1997), a 10-item scale (e.g., "*I easily become wrapped up in my own interests and forget the existence of others*") rated from 0 ("*Not at all like me*") to 5 ("*Completely like me*"), that was translated to French using the back-translation method.

2.5. Procedure

Participants were greeted in our lab by pairs of two. They were then separated with one completing all the scales included in the study in a quiet room while the other participant completed eye-tracker measures in an experimental room. The experimental room with the eye-tracker consisted in two spaces separated by a partition wall with one space where the participant was seated to perform the calibration and the test, and the other space for the experimenter using the host computer associated to the eye-tracker. Hence, the participant was not able to see the experimenter and vice-versa. After completion of the experimental task, the participant was led to the other quiet room to complete the questionnaires and the other participant who started with the questionnaire completion was led to the experimental room to perform the eye-tracker study.[4] At the end of the study, both participants were debriefed together in the quiet room where they completed the questionnaires.

3. Results

3.1. Descriptive analysis of personality and basic oculometric measures

In this section, we evaluate personality measures as well as the basic oculometric measures directly derived from the eye-tracker system. All personality measures show satisfying reliability with Cronbach Alpha (and Guttman Lambda 4 in the case of NPI using binomial scores, see Benton, 2015) between 0.72 and 0.88. Except for private self-consciousness, public self-consciousness, social anxiety and grandiose narcissism, all personality variables were normally distributed as indicated by Shapiro-Wilks tests (see SOM for the distributions). As expected, personality traits were almost all significantly related with one another as shown through Spearman correlations of personality scores at the participants' level (see Table 2). Dwell time and number of saccades were also positively correlated, although in a non-linear shape, (see SOM). In contrast, vergence was not significantly related to the two others main oculometric indexes. Basic oculometric indexes (i.e., dwell time, number of saccades toward AOI, and ocular vergence) and personality traits did not consistently correlate: only dwell time appeared to predict Public Self-Consciousness and Vulnerable narcissism. Marginal associations were also observed between dwell time and grandiose narcissism, dwell time and Social Anxiety, and number of saccades towards the self and grandiose narcissism.

3.2. Machine learning approach

In order to gain understanding in the most influential personality variables on the three basic oculometric measures of self-directed attention, we performed models using Machine Learning (ML). ML advantages in the current situation are threefold: 1) it does not suffer from collinearity (which might be problematic in this study because of the high correlation between all the predictors), 2) it does not assume linear relationship between variables, and 3) to the extent that it provides insight in how variables explain other variables without relying on null

[4] Because of absent participants, the order sequence of the procedure was not equally balanced with 43 participants first completing the eye-tracking measures before the questionnaire and 61 participants starting with the questionnaire before the eye-tracking measures. However, controlling for the order sequence did not influence the statistical decisions reported in the article.

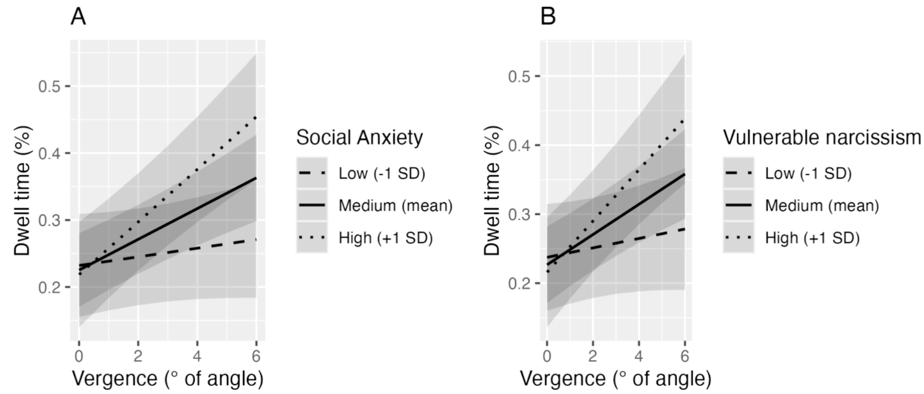

Fig. 1. Interaction between ocular vergence and social anxiety (A) and vulnerable narcissism (B) on proportion of time spent on the screen zone reflecting the participant's face.

Table 2
Correlation matrix of personality variables (reliability indexes in diagonal) and ocular measures.

	PrSC	PubSC	SocAnx	PrSA	PubSA	Rosenberg	CES-D	NPI	HSNS	Dwell	Sacc	Verg
PrSC	$\alpha = 0.73$	0.29**	0.09	0.26**	0.10	0.05	0.06	0.13	0.15	–0.02	–0.11	–0.03
PubSC	–	$\alpha = 0.78$	0.33**	0.27**	0.55***	–0.17	0.11	–0.04	0.30**	**0.21***	–0.05	–0.01
SocAnx	–	–	$\alpha = 0.83$	0.24*	0.45***	–0.34***	0.37***	–0.35***	0.49***	0.20•	0.15	0.06
PrSA	–	–	–	$\alpha = 0.79$	0.52***	–0.23*	0.26*	–0.03	0.64***	0.17	0.10	0.14
PubSA	–	–	–	–	$\alpha = 0.88$	–0.42***	0.38***	–0.14	0.66***	0.14	0.09	0.10
Rosenberg	–	–	–	–	–	$\alpha = 0.88$	–0.55***	0.35***	–0.33***	–0.15	–0.06	0.09
CES-D	–	–	–	–	–	–	$\alpha = 0.84$	–0.23*	0.34***	0.06	0.10	0.08
NPI	–	–	–	–	–	–	–	$\lambda 4 = 0.84$	–0.08	–0.18•	–0.19•	–0.13
HSNS	–	–	–	–	–	–	–	–	$\alpha = 0.77$	**0.20***	0.10	0.13
Dwell	–	–	–	–	–	–	–	–	–	N/A	0.48***	0.13
Sacc	–	–	–	–	–	–	–	–	–	–	N/A	–0.02
Verg	–	–	–	–	–	–	–	–	–	–	–	N/A

α: Cronbach alpha; $\lambda 4$: Guttman Lambda 4; PrSC: Private Self-Consciousness (M=3.58, SD=0.66); PubSC: Public Self-Consciousness (M=3.63, SD=0.77); SocAnx: Social Anxiety (M=3.20, SD=1.14); PrSA: Private Self-Absorption (M=1.59, SD=0.81); PubSA: Public Self-Absorption (M=2.46, SD=1.09); Rosenberg: Self-Esteem (M=2.86, SD=0.90); CES-D: Depression (M=3.15, SD=0.87); NPI: Grandiose narcissism (M=0.30, SD=0.18); HNSN: Vulnerable narcissism (M=2.18, SD=0.84); Dwell: Dwell time (M=27.4 % of the inter-trial interval spent on the AOI, SD=27.2 %); Sacc: Number of saccades toward the AOI (M=1.50 saccades per inter-trial interval, SD=0.84); Verg: average vergence on the AOI (M=2.01°, SD=0.65). ***: $p < 0.001$, **: $p < 0.01$; *: $p < 0.05$, •: < 0.1.

hypothesis statistical testing, it is particularly recommended for exploratory studies such as this one. In contrast to the previous analyses, this approach allows the evaluation of the relative contribution of each predictor in the models, but not how good they are at predicting the outcome independently.

For each of the main oculometric outcomes, we first performed 5-fold cross-validation to identify the number of predictors resulting in the lowest Root Mean Squared Error (RMSE). Five-fold cross-validation splits the data into five parts (i.e., folds), and each part is used iteratively as a training set while the rest of the data serves as a validation set. For each iteration, the RMSE associated with different numbers of predictors is estimated and averaged, providing a general estimation of the optimal number of predictors to consider in the model.

Then, we used this number of predictors to select the ones with the most influence on the data by looking at the increased node purity in a random forest model trained on 70 % of the data with 500 trees. Because increased node purity is not a standardized metric, comparisons across different models are not possible. Thus, we only describe the variables associated with the largest increases in node purity. To sum up, we aimed to identify variables contributing to the oculometric outcomes in the most parsimonious random forest model. For each model, we report the associated RMSE and R^2 (indicating the proportion of variance of the outcome explained by our predictors in the model) to indicate the fitness of the models (for primers on machine learning, see Boehmke & Greenwell, 2019; Brownlee, 2016). Analyses were carried out using the "caret" package (Kuhn, 2008, see codes and results in SOM).

Dwell time. Regarding time spent looking at the self, 5-fold cross validation indicated that using five predictors in the model yielded the smallest RMSE (RMSE=.27). The random forest model trained on 70 % of the data was associated to a RMSE of 0.26 and $R^2 = 5.34$ % – suggesting a moderate fitness of the model. Public self-consciousness, Private self-consciousness, Private self-absorption, and Social anxiety were closely competing as the most important variables in the model, followed by Self-esteem and Public self-consciousness.

Number of saccades toward the AOI. Considering 2 of the 9 predictors resulted in the smallest RMSE in a 5-fold cross validation (RMSE=0.86). The final random forest model predicting the number of saccades in the AOI was associated to a RMSE of 0.72 and $R^2 = 9.50$ % suggesting a good fit of the model. The model indicated that Private self-absorption was an important predictor in the model. Public self-absorption was the second most important predictor in the model.

Vergence. RMSE was reduced for two predictors here again (RMSE=.67). The random forest model predicting ocular vergence was associated to a RMSE of 0.68 and a $R^2 = 0.14$ %, suggesting a bad fit of the model. Analysis of the increased node purity associated to each predictor of the model indicated that private self-absorption was the most important predictor in the model, followed by Private self-consciousness.

3.3. *Analyses on self-focus*

Independent mixed models (i.e., one model per predictor) predicting dwell time using personality traits, ocular vergence, and their interaction as predictors were performed using the *lmer* function from the lme4 package in R (Bates et al., 2015; see Table 3). Participant level and inter-trial durations were used as random variables in the models. In all models, vergence had a main effect on dwell time such that the more people looked through the screen, the less time they spent on the area of the screen reflecting their face – without accounting for any personality trait, B=0.02, SE=0.0049, *95 %CI* [0.01, 0.029], $p < 0.001$.

Of all the pool of predictors, only social anxiety, B=0.016, SE=0.0049, *95 %CI* [0.0066, 0.026] $p < 0.001$, and vulnerable narcissism, B=0. 015, SE=0.0049, *95 %CI* [0.0051, 0.024], $p = 0.003$ significantly predicted self-focus. High scores (+1SD) of social anxiety and vulnerable narcissism were associated to strong negative associations between dwelling on the self-reflecting area of the screen and looking through the screen, respectively t(3991.34) = 5.15, p < 0.0001 and t (3970.58) = 4.92, p < 0.0001. On the other hand, low scores (–1 SD) of social anxiety and vulnerable narcissism nullified this association, respectively $t(3977.17) = 1.03$, $p = 0.30$ and $t(3987.05) = 1.06$, $p = 0.29$ (see Fig. 1).[5]

Intra Class Correlations (*ICC*) greater than 60 % were observed for the individual level random variable in the models. Such high *ICC* suggest an important heterogeneity in the baseline outcome for each participant and underline the importance of using mixed models instead of analysing self-focus at the participant level through classic Ordinary Least Squares models (for details regarding this level of analysis, see SOM).

4. Discussion

Despite an important tradition dating back to William James early theoretical considerations of the self (James, 1890/1981), it is noteworthy that studies have consistently relied on self-reported measures of one's proneness to direct their attention toward the self. Such measures fail to assess an actual behavior and are inherently biased by the fact that they require self-directed attention to be measured. Eye-tracking technology have been used to promote a more precise measure of self-directed attention (Ariss et al., 2023; Bauer et al., 2017; Bortolon et al., 2016; Lin et al., 2021; Monéger et al., 2022; Potthoff & Schienle, 2021; Vriends et al., 2017). Among them, the recent I-ME paradigm (Monéger et al., 2022) seemed particularly promising but, to our knowledge, no studies assessed the theoretical validity of this paradigm.

To assess I-ME paradigm paradigm ability to capture self-directed attention, this study capitalized on existing tools conceptually linked to self-focus: a pool of self-reported measures of personality traits that have been consistently linked to increased or decreased levels of self-directed attention. Among them, facets of self-consciousness – the disposition to direct one's attention toward the self – have been hypothesized to predict self-directed attention.

Do basic eye-tracking indexes can capture self-directed attention? Although basic oculometric measures of self-directed attention failed to account for private self-consciousness (i.e. proneness to direct one's attention to internal thoughts and feelings), dwell time was significantly predicted by public self-consciousness and only marginally so by social anxiety. Accordingly, some basic measures might tack concerns with public aspects of the self, but not concerns with private aspects of the self (e.g., attitudes, thoughts, emotions).

Additional correlations between basic oculometric indices and personality traits emphasize the type of motives that might be captured in the I-ME paradigm. Vulnerable narcissism was associated to longer dwell time, and grandiose narcissism marginally predicted shorter dwell time and less saccades made toward one's own self-reflected face (these marginal associations became significant when deleting participants with low accuracy scores, see Footnote 5).

To further understand the nature of eye-tracked self-directed attention, we assessed the relative contribution of features in our pool of predictors using random forest models, unsensitive to collinearity and allowing the modelling of nonlinear relationships. Random forest models provided satisfying fit for dwell time and saccades, but not ocular vergence – further emphasizing that this outcome fails to capture self-directed attention on its own (see correlation matrix). Our models consistently indicated that self-absorption was the most influential predictors of these basic oculometric measures. Importantly, private self-absorption corresponds to the maladaptive excessive focus on the self and have been consistently related to various clinical disorders (Ingram, 1990 for a review).

These exploratory results might indicate the relevance of eye-trackers in capturing maladaptive self-focused attention. Future studies might assess how the I-ME paradigm can capture fluctuations in self-focus among populations known for their high private self-absorption levels, such as individuals suffering from body dysmorphia (Neziroglu et al., 2008; Toh et al., 2017; Veale & Riley, 2001), alcohol dependence (de Timary et al., 2013; Hull, 1981; for an eye-tracking study, see Ariss et al., 2023) social anxiety (Judah et al., 2016; Spurr & Stopa, 2002; for eye-tracking studies, see Lin et al., 2021; Vriends et al., 2017) or depression (Berry-Blunt et al., 2021; Mor & Winquist, 2002; Sakamoto, 2000; Takano & Tanno, 2009; Watkins, 2004).

In addition to the evaluation of basic oculometric measures, the current investigation proposed a novel measure of self-focus defined as the association between ocular vergence and dwell time. This self-focus measure accounted for the shortcoming of dwell time – that might be increased by a general tendency to focus on the center of the screen – by integrating the effect of ocular vergence (depth of the visual focus). In mixed models, Dwell time and ocular vergence were correlated, indicating that the more time one spends on the part of the screen reflecting at the self, the less they gaze behind the screen. This latter relationship might indicate a self-avoidant behavior with people gazing through the screen preferring shorter stays on their reflection and individuals preferring long stays on the center of the screen avoiding gazing toward the self. This pattern was qualified by two personality traits (namely Social anxiety and vulnerable narcissism) that both show a relation to the clinical sphere (Erkoreka & Navarro, 2017; Huprich et al., 2012; Sawaoka et al., 2012), once again underscoring the possible relevance of the I-ME paradigm to investigate self-directed attention in at-risk populations. Interestingly, this new measure failed to predict public self-consciousness, despite this trait predicting dwell time. This discrepancy suggests a nuance between '*looking at a mirror*' (dwell time) and '*looking through a mirror*' (self-focus). Social anxiety predicts increased dwell time but reduced self-focus, indicating socially anxious individuals might be drawn to self-directed attention but averse to self-focus. Conversely, public self-consciousness was not associated to aversion to self-focus.

However, while those preliminary results regarding the relevance and practical interests of eye-tracking systems in monitoring self-directed attention are encouraging, some notable limitations are to be underlined. First of all, this work constitutes an exploratory investigation. As such, confirmatory evidences of the paradigm's strengths are required to confirm the current findings. Such confirmatory evidence would ideally stem from more clinical investigations, or from studies focusing on at-risk populations. Moreover, the current investigation did not evaluate the interest of the I-ME paradigm by considering a costs/benefits balance. Using eye-tracking systems to evaluate self-directed

[5] Correcting vergence using the average vergence when looking at targets did not change the statistical decisions reported here. Additionnally, we considered accuracy rates. Accuracy scores were generally high (M = 93.92%, SD = 8.56%). Sensitivity analyses excluding participants with accuracy scores deviating from more than 2.5MAD from the median (Leys et al., 2017) did not result in any change in our statistical decision with the exception of grandiose narcissism significantly predicting less dwell time and saccades in our correlational analyses, respectively $r = -0.22$, $p = 0.038$, and $r = -0.22$, $p = 0.032$, see SOM.

Table 3
Personality traits moderations of the effect of vergence on dwell time.

Predictor	*B*	*SE*	95 %CI	*p* value	BIC Null model	BIC Model	ICC individual level	ICC time interval
PrSC	0.0042	0.0051	[–0.0058, 0.014]	0.41	–1217	–1209.4	61 %	1 %
PubSC	0.0048	0.0052	[–0.0053, 0.015]	0.35	–1219.9	–1212.4	60 %	1 %
SocAnx	0.016	0.0049	[0.0066, 0.026]	< 0.001***	–1267.5	–1278.5	60 %	1 %
PrSA	0.0063	0.0054	[–0.0042, 0.017]	0.24	–1219.7	–1212.8	60 %	1 %
PubSA	–0.0019	0.0051	[–0.012, 0.008]	0.71	–1217.5	–1209.3	61 %	1 %
Rosenberg	–0.00076	0.005	[–0.011, 0.0091]	0.88	–1218.1	–1209.8	61 %	1 %
CES–D	0.0009	0.0051	[–0.009, 0.011]	0.85	–1216.7	–1208.4	61 %	1 %
NPI	–0.001	0.0049	[–0.011, 0.0086]	0.83	–1217.6	–1209.4	61 %	1 %
HSNS	0.015	0.0049	[0.0051, 0.024]	0.003**	–1217.4	–1218.1	61 %	1 %

PrSC: Private Self-Consciousness; PubSC: Public Self-Consciousness; SocAnx: Social Anxiety; PrSA: Private Self-Absorption; PubSA: Public Self-Absorption; Rosenberg: Self-Esteem; CES-D: Depression; NPI: Grandiose narcissism; HNSN: Vulnerable narcissism; BIC: Bayesian Information Criteria, ICC: Intra Class Correlation. BIC associated to the null model are given for comparison purposes with the BIC of the full model. ***: $p < 0.001$, **: $p < 0.01$; *: $p < 0.05$, •: < 0.1.
Note: Positive betas indicate reduced self-focus, whereas negative betas indicate increased self-focus.

attention must be accompanied by weighting the efficiency of the tools (yet to be confirmed in future registered studies, although see Monéger et al., 2022) against the practical cost of acquiring an eye-tracking system and using it. Nevertheless, eye-tracking systems have grown increasingly popular over the last decade, and pricing and usability have evolved to make these tools more and more widely accessible. Furthermore, we acknowledge that the selected pool of predictors offers a limited scope of analysis. Future studies might do well expanding the spectrum of predictors of self-directed attention by adding variables that would either (1) specify more accurately motives behind self-directed attention in this paradigm (e.g., appearance self-esteem or appearance anxiety) or (2) illustrate competing mechanisms of self-directed attention (e.g., extraversion or openness to experience that might explain attention to the self as mere interest in an engaging stimulus). Finally, it can be noted the constraints on generality by emphasizing that our participants were undergraduate students in a medium-sized Western European university including mostly young white women. Future research should identify to what extent our findings would replicate outside an academic setting, and/or using a different population. To this end, our material is available on the publicly accessible OSF webpage associated to the project.

5. Conclusion

We investigated the ability of modern eye-tracking systems to monitor actual self-directed attention (instead of self-reported proneness to direct attention toward the self) by using a paradigm that demonstrated its ability to capture variations in self-directed attention consequent to a failure (vs success) manipulation. The study questioned the validity of the tool in measuring the construct of self-awareness by assessing its ability to capture personality variables that were consistently shown to be associated to self-directed attention. Although results are mixed, dwell time on the area of the screen reflecting the participant's face did capture a small part of the variance of vulnerable narcissism and public self-consciousness. Moreover, a novel and more precise indicator of self-focus (or rather self-focus avoidance in our analyses) successfully identified vulnerable narcissism and social anxiety. A machine learning approach further emphasized self-absorption as the most important underlying predictor of the basic eye-tracking measures. Taken together, this preliminary investigation indicates that actual behavioral maladaptive self-directed attention could be accurately captured by using eye-trackers. These findings suggest exciting future directions for experimental psychologists interested in self-awareness.

CRediT authorship contribution statement

Jean Monéger: Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Nicolas Noiret:** Writing – review & editing, Supervision, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data, codes, and materials is available on OSF webpage linked in the manuscript.

References

Ariss, T., Fairbairn, C. E., Sayette, M. A., Velia, B. A., Berenbaum, H., & Brown-Schmidt, S. (2023). Where to look? Alcohol, affect, and gaze behavior during a virtual social interaction. *Clinical Psychological Science : A Journal of the Association for Psychological Science, 11*(2), 239–252. https://doi.org/10.1177/21677026221096449

Armstrong, T., & Olatunji, B. O. (2012). Eye tracking of attention in the affective disorders: A meta-analytic review and synthesis. *Clinical Psychology Review, 32*(8), 704–723. https://doi.org/10.1016/j.cpr.2012.09.004

Arndt, J., Greenberg, J., Simon, L., Pyszczynski, T., & Solomon, S. (1998). Terror Management and Self-Awareness: Evidence that Mortality Salience Provokes Avoidance of the Self-Focused State. *Personality and Social Psychology Bulletin, 24*(11), 1216–1227. https://doi.org/10.1177/01461672982411008

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software, 67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Bauer, A., Schneider, S., Waldorf, M., Braks, K., Huber, T. J., Adolph, D., & Vocks, S. (2017). Selective Visual Attention Towards Oneself and Associated State Body Satisfaction: An Eye-Tracking Study in Adolescents with Different Types of Eating Disorders. *Journal of Abnormal Child Psychology, 45*(8), 1647–1661. https://doi.org/10.1007/s10802-017-0263-z

Benton, T. (2015). An empirical assessment of Guttman's Lambda 4 reliability coefficient. In *Quantitative psychology research: The 78th annual meeting of the Psychometric Society* (pp. 301-310). Springer International Publishing.

Berry-Blunt, A. K., Holtzman, N. S., Donnellan, M. B., & Mehl, M. R. (2021). The story of "I" tracking: Psychological implications of self-referential language use. *Social and Personality Psychology Compass, 15*(12), e12647.

Besser, A., & Priel, B. (2010). Grandiose narcissism versus vulnerable narcissism in threatening situations: Emotional reactions to achievement failure and interpersonal rejection. *Journal of Social and Clinical Psychology, 29*(8), 874–902. https://doi.org/10.1521/jscp.2010.29.8.874

Boehmke, B., & Greenwell, B. M. (2019). Hands-On Machine Learning with R. *Chapman and Hall/CRC.* https://doi.org/10.1201/9780367816377

Bortolon, C., Capdevielle, D., Salesse, R. N., & Raffard, S. (2016). Self-Face Recognition in Schizophrenia: An Eye-Tracking Study. *Frontiers in Human Neuroscience, 10.* https://doi.org/10.3389/fnhum.2016.00003

Braun, S., Kempenaers, C., Linkowski, P., & Loas, G. (2016). French Adaptation of the Narcissistic Personality Inventory in a Belgian French-Speaking Sample. *Frontiers in Psychology, 7.* https://www.frontiersin.org/articles/10.3389/fpsyg.2016.01980.

Brockner, J., & Wallnau, L. B. (1981). Self-esteem, anxiety, and the avoidance of self-focused attention. *Journal of Research in Personality, 15*(3), 277–291. https://doi.org/10.1016/0092-6566(81)90026-X

Brownlee, J. (2016). Machine Learning MasteryMachine Learning Mastery With R: Get Started, Build Accurate Models and Work Through Projects Step-by-Step. Machine Learning Mastery.

Carey, A. L., Brucks, M. S., Küfner, A. C. P., Holtzman, N. S., Große Deters, F., Back, M. D., Donnellan, M. B., Pennebaker, J. W., & Mehl, M. R. (2015). Narcissism and the use of personal pronouns revisited. *Journal of Personality and Social Psychology, 109*(3), e1–e15. https://doi.org/10.1037/pspp0000029

Carver, C. S., & Scheier, M. F. (1981). Attention and Self-Regulation: A Control-Theory Approach to Human Behavior. *Springer-Verlag.* https://doi.org/10.1007/978-1-4612-5887-2

Chita-Tegmark, M. (2016). Social attention in ASD: A review and meta-analysis of eye-tracking studies. *Research in Developmental Disabilities, 48*, 79–93. https://doi.org/10.1016/j.ridd.2015.10.011

de Timary, P., de Sousa, C., Uva, M., Denoël, C., Hebborn, L., Derely, M., Desseilles, M., & Luminet, O. (2013). The associations between self-consciousness, depressive state and craving to drink among alcohol dependent patients undergoing protracted withdrawal. *PloS One, 8*(8), e71560.

Duval, S., & Wicklund, R. A. (1972). *A theory of objective self awareness* (pp. x, 238). Academic Press.

Erkelens, C. J., Van Der Steen, J., Steinman, R. M., Collewijn, H., & Westheimer, G. (1997). Ocular vergence under natural conditions. I. Continuous changes of target distance along the median plane. *Proceedings of the Royal Society of London. B. Biological Sciences, 236*(1285), 417–440. https://doi.org/10.1098/rspb.1989.0030

Erkoreka, L., & Navarro, B. (2017). Vulnerable narcissism is associated with severity of depressive symptoms in dysthymic patients. *Psychiatry Research, 257*, 265–269. https://doi.org/10.1016/j.psychres.2017.07.061

Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology, 43*(4), 522–527. https://doi.org/10.1037/h0076760

Hendin, H. M., & Cheek, J. M. (1997). Assessing hypersensitive narcissism: A reexamination of Murray's Narcism Scale. *Journal of Research in Personality, 31*(4), 588–599. https://doi.org/10.1006/jrpe.1997.2204

Horvath, S., & Morf, C. C. (2009). Narcissistic defensiveness: Hypervigilance and avoidance of worthlessness. *Journal of Experimental Social Psychology, 45*(6), 1252–1258. https://doi.org/10.1016/j.jesp.2009.07.011

Hull, J. G. (1981). A self-awareness model of the causes and effects of alcohol consumption. *Journal of Abnormal Psychology, 90*(6), 586–600. https://doi.org/10.1037/0021-843X.90.6.586

Hull, J. G., & Young, R. D. (1983). Self-consciousness, self-esteem, and success–failure as determinants of alcohol consumption in male social drinkers. *Journal of Personality and Social Psychology, 44*(6), 1097–1109. https://doi.org/10.1037/0022-3514.44.6.1097

Huprich, S., Luchner, A., Roberts, C., & Pouliot, G. (2012). Understanding the association between depressive personality and hypersensitive (vulnerable) narcissism: Some preliminary findings. *Personality and Mental Health, 6*(1), 50–60. https://doi.org/10.1002/pmh.176

Ingram, R. E. (1990). Self-focused attention in clinical disorders: Review and a conceptual model. *Psychological Bulletin, 107*(2), 156–176. https://doi.org/10.1037/0033-2909.107.2.156

James, W. (1890/1981). *The principles of psychology*. Cambridge: Harvard University Press.

Jauk, E., & Kanske, P. (2021). Can neuroscience help to understand narcissism? A systematic review of an emerging field. *Personality Neuroscience, 4*. https://doi.org/10.1017/pen.2021.1

Judah, M. R., Grant, D. M., & Carlisle, N. B. (2016). The effects of self-focus on attentional biases in social anxiety: An ERP study. *Cognitive, Affective & Behavioral Neuroscience, 16*(3), 393–405. https://doi.org/10.3758/s13415-015-0398-8

Konrath, S., Bushman, B. J., & Grove, T. (2009). Seeing My World in a Million Little Pieces: Narcissism, Self-Construal, and Cognitive-Perceptual Style. *Journal of Personality, 77*(4), 1197–1228. https://doi.org/10.1111/j.1467-6494.2009.00579.x

Konrath, S., Meier, B. P., & Bushman, B. J. (2014). Development and Validation of the Single Item Narcissism Scale (SINS). *PLOS ONE, 9*(8), e103469.

Kuhn, M. (2008). Building predictive models in R using the caret package. *Journal of statistical software, 28*, 1–26.

Landrault, H., Jaafari, N., Amine, M., Malka, G., Selimbegović, L., & Chatard, A. (2020). Suicidal Ideation in Elite Schools: A Test of the Interpersonal Theory and the Escape Theory of Suicide. *Suicide and Life-Threatening Behavior, 50*(1), 201–210. https://doi.org/10.1111/sltb.12578

Lin, M., Wen, X., Qian, M., He, D., & Zlomuzica, A. (2021). Self-focused attention vs. Negative attentional bias during public speech task in socially anxious individuals. *Behaviour Research and Therapy, 136*, Article 103766. https://doi.org/10.1016/j.brat.2020.103766

Lipson, A. L., Przybyla, D. P., & Byrne, D. (1983). Physical attractiveness, self-awareness, and mirror-gazing behavior. *Bulletin of the Psychonomic Society, 21*(2), 115–116. https://doi.org/10.3758/BF03329969

McKenzie, K. S., & Hoyle, R. H. (2008). The Self-Absorption Scale: Reliability and validity in non-clinical samples. *Personality and Individual Differences, 45*(8), 726–731. https://doi.org/10.1016/j.paid.2008.07.020

Miller, J. D., Back, M. D., Lynam, D. R., & Wright, A. G. C. (2021). Narcissism today: What we know and what we need to learn. *Current Directions in Psychological Science, 30*(6), 519–525. https://doi.org/10.1177/09637214211044109

Monéger, J., Chatard, A., & Selimbegović, L. (2022). (Eye-)tracking the escape from the self: Guilt proneness moderates the effect of failure on self-avoidance. *Cognition & Emotion, 1–15*. https://doi.org/10.1080/02699931.2022.2126441

Monéger, J., Chatard, A., & Selimbegović, L. (2023). The defeated self: Evidence that entrapment moderates first name priming effects on failure-thought accessibility. *Self and Identity, 22*(3), 333–350. https://doi.org/10.1080/15298868.2022.2099454

Mor, N., & Winquist, J. (2002). Self-focused attention and negative affect: A meta-analysis. *Psychological Bulletin, 128*(4), 638–662. https://doi.org/10.1037/0033-2909.128.4.638

Morin, A. J. S., Moullec, G., Maïano, C., Layet, L., Just, J.-L., & Ninot, G. (2011). Psychometric properties of the Center for Epidemiologic Studies Depression Scale (CES-D) in French clinical and nonclinical adults. *Revue D'epidemiologie Et De Sante Publique, 59*(5), 327–340. https://doi.org/10.1016/j.respe.2011.03.061

Neziroglu, F., Khemlani-Patel, S., & Veale, D. (2008). Social learning theory and cognitive behavioral models of body dysmorphic disorder. *Body image, 5*(1), 28–38. https://doi.org/10.1016/j.bodyim.2008.01.002

Pelletier, L. G., & Vallerand, R. J. (1990). L'Échelle Révisée de Conscience de Soi: Une traduction et une validation canadienne-française du Revised Self-Consciousness Scale. [The Revised Self-Consciousness Scale: A translation and a French-Canadian validation of the Revised Self-Consciousness Scale.]. *Canadian Journal of Behavioural Science / Revue Canadienne Des Sciences Du Comportement, 22*(2), 191–206. https://doi.org/10.1037/h0078983

Potthoff, J., & Schienle, A. (2021). Effects of Self-Esteem on Self-Viewing: An Eye-Tracking Investigation on Mirror Gazing. *Behavioral Sciences (Basel, Switzerland), 11*(12), 164. https://doi.org/10.3390/bs11120164

Pyszczynski, T., & Greenberg, J. (1985). Depression and preference for self-focusing stimuli after success and failure. *Journal of Personality and Social Psychology, 49*(4), 1066–1075. https://doi.org/10.1037//0022-3514.49.4.1066

Radloff, L. S. (1977). The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Applied Psychological Measurement, 1*(3), 385–401. https://doi.org/10.1177/014662167700100306

Raskin, R. N., & Hall, C. S. (1979). *A Narcissistic Personality Inventory. Psychological Reports, 45*(2), 590. https://doi.org/10.2466/pr0.1979.45.2.590

Raskin, R. N., & Shaw, R. (1988). Narcissism and the Use of Personal Pronouns. *Journal of Personality, 56*(2), 393–404. https://doi.org/10.1111/j.1467-6494.1988.tb00892.x

Rosenberg, M. (1965). Society and the Adolescent Self-Image. *Princeton University Press.* http://www.jstor.org/stable/j.ctt183pjjh.

Sakamoto, S. (2000). Self-focus and depression: The three-phase model. *Behavioural and Cognitive Psychotherapy, 28*(1), 45–61.

Sawaoka, T., Barnes, R. D., Blomquist, K. K., Masheb, R. M., & Grilo, C. M. (2012). Social anxiety and self-consciousness in binge eating disorder: Associations with eating disorder psychopathology. *Comprehensive Psychiatry, 53*(6), 740–745. https://doi.org/10.1016/j.comppsych.2011.10.003

Scalabrini, A., Huang, Z., Mucci, C., Perrucci, M. G., Ferretti, A., Fossati, A., Romani, G. L., Northoff, G., & Ebisch, S. J. H. (2017). How spontaneous brain activity and narcissistic features shape social interaction. *Scientific Reports, 7*(1), 9986. https://doi.org/10.1038/s41598-017-10389-9

Sedikides, C. (1992). Attentional effects on mood are moderated by chronic self-conception valence. *Personality and Social Psychology Bulletin, 18*(5), 580–584. https://doi.org/10.1177/0146167292185008

Sedikides, C. (2021). In search of narcissus. *Trends in Cognitive Sciences, 25*(1), 67–80. https://doi.org/10.1016/j.tics.2020.10.010

Spurr, J. M., & Stopa, L. (2002). Self-focused attention in social phobia and social anxiety. *Clinical Psychology Review, 22*(7), 947–975. https://doi.org/10.1016/S0272-7358(02)00107-1

Takano, K., & Tanno, Y. (2009). Self-rumination, self-reflection, and depression: Self-rumination counteracts the adaptive effect of self-reflection. *Behaviour Research and Therapy, 47*(3), 260–264. https://doi.org/10.1016/j.brat.2008.12.008

Toh, W. L., Castle, D. J., & Rossell, S. L. (2017). How individuals with body dysmorphic disorder (BDD) process their own face: A quantitative and qualitative investigation based on an eye-tracking paradigm. *Cognitive neuropsychiatry, 22*(3), 213–232. https://doi.org/10.1080/13546805.2017.1300090

Twenge, J. M., Catanese, K. R., & Baumeister, R. F. (2003). Social exclusion and the deconstructed state: Time perception, meaninglessness, lethargy, lack of emotion, and self-awareness. *Journal of Personality and Social Psychology, 85*(3), 409–423. https://doi.org/10.1037/0022-3514.85.3.409

Vallières, E. F., & Vallerand, R. J. (1990). Traduction et validation canadienne-française de l'Échelle de l'Estime de Soi de Rosenberg. [French-Canadian translation and validation of Rosenberg's Self-Esteem Scale.]. *International Journal of Psychology, 25*(3), 305–316. https://doi.org/10.1080/00207599008247865

Veale, D., & Riley, S. (2001). Mirror, mirror on the wall, who is the ugliest of them all? The psychopathology of mirror gazing in body dysmorphic disorder. *Behaviour Research and Therapy, 39*(12), 1381–1393. https://doi.org/10.1016/S0005-7967(00)00102-9

Vriends, N., Meral, Y., Bargas-Avila, J. A., Stadler, C., & Bögels, S. M. (2017). How do I look? Self-focused attention during a video chat of women with social anxiety (disorder). *Behaviour Research and Therapy, 92*, 77–86. https://doi.org/10.1016/j.brat.2017.02.008

Wann, J. P., Rushton, S., & Mon-Williams, M. (1995). Natural problems for stereoscopic depth perception in virtual environments. *Vision Research, 35*(19), 2731–2736. https://doi.org/10.1016/0042-6989(95)00018-U

Watkins, E. (2004). Adaptive and maladaptive ruminative self-focus during emotional processing. *Behaviour Research and Therapy, 42*(9), 1037–1052. https://doi.org/10.1016/j.brat.2004.01.009

Watson, P. J., & Biderman, M. D. (1993). Narcissistic personality inventory factors, splitting, and self-consciousness. *Journal of Personality Assessment, 61*(1), 41–57. https://doi.org/10.1207/s15327752jpa6101_4