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May I Have Your Attention? Testing a Subjective Attention Scale

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May I Have Your Attention? Testing a Subjective Attention Scale

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Abstract

The concept of 'attention' – our ability to focus on particular parts of the world - is a seemingly simple one. Research, however, often driven by clinicians need to diagnose attentional deficits after brain injuries, has demonstrated its complexity. This has resulted in significant testing being required to assess the full range of attentional abilities. Herein, we designed a Subjective Attention Scale, consisting of 15 Likert-scale questions based on five types of attention identified by Sohlberg and Mateer (1989). Preliminary data suggested the scale had good psychometric properties (Cronback's $\alpha > 0.8$) and an interpretable factor structure (4 factors; 49% of variance). However, it showed almost no significant correlations with measures from six laboratory tests of attention. Instead, analyses suggest peoples' subjective beliefs regarding their attentional abilities map more closely onto the Conscientiousness personality trait than those traits identified from clinical work.

Keywords: attention; subjective attention; inhibition; metacognition; cognitive ability; personality.

Introduction

Attention is fundamental to our experience of the world - our ability to divide limited cognitive abilities across the world's interesting features (Anderson, 2000). What it is and how it works, though, is subject to ongoing debate, with common views often following the 'pool of attention' analogy (Kahneman, 1973), which is easy to understand but ignores the likelihood that each mode of information receival (audio, visual, etc) has some attentional bandwidth of its own (see, e.g., Wahn & König, 2017).

That is, while 'attention' can feel like a singular resource, research suggests it is a combination of abilities. For example, work with traumatic brain injury (TBI) patients suggests the underlying mechanisms of attention can remain intact while the ability to strategically deploy attentional resources can be lost – leading to deficits on some measures but not others (Whyte, Hart, Bode, & Malec, 2003).

Such work has shown deficits following TBI are more common in complex attention tasks like switching and dividing attention, leading to hierarchical models of attention like Sohlberg and Mateer's (1989). This describes attention along lines of increasing complexity:

1. *Focused attention*. Discretely respond to stimuli.
2. *Sustained attention*. Maintain vigilance across a task.
3. *Selective attention*. Ignore extraneous stimuli or distractors during tasks.
4. *Alternating attention*. Switch back and forth between tasks requiring different cognitive resources.
5. *Divided attention*. Attend to two or more separate tasks simultaneously.

This model allows patients to be assessed on their level of deficit to enable treatment decisions – using tests of differing types of attention. For example, the Test of Variables of Attention (TOVA; Greenberg & Waldmant, 1993) and Sustained Attention to Response Task (SART; Warm, 1984) are both commonly used diagnostically for TBI or attentional disorders such as ADHD, but measure quite different things – what Sohlberg and Mateer (and others; see, e.g., Whyte, Polansky, Fleming, Coslett, & Cavallucci, 1995) would call *sustained attention* in the first but *inhibition* of automatic responses in the latter. These tasks compare patients with baseline, non-pathological performance but also allow discussions of variability in normal attentional abilities; that is, individual differences.

This is important as attention may underpin cognitive activities like decision making. For example, in Two Systems theories of decision making, System 1 describes intuitive, unconscious processing while System 2 describes rational, conscious processing (see, e.g., Stanovich & West, 2000). Attention, however, may fit the bill as the 'missing' functions that allow the detection/inhibition of errors, prompting switches between systems (see, e.g., the description of 'cognitive reflection' and its relationships to other measures in: Frederick, 2005; Welsh, Burns, & Delfabbro, 2013). Thus, understanding individual differences in attention may shed light on why people differ in decision making ability.

Regardless of whether we are considering pathological or normal cognition, though, if attention is multi-faceted, a battery of tests is required to determine a person's ability to attend in these different ways. This is a problem as attention tasks tend to be long and unpleasant for participants (anecdotally, at least). For example, to test one type of attention listed by Sohlberg and Mateer (1989), the TOVA (Greenberg & Waldmant, 1993) runs for 23 minutes. Testing multiple attentional abilities is thus a serious undertaking, requiring lab-work and running the risk of alienating participants.

Given this, the development of a survey-based test, allowing participant to rate their own attentional abilities, is an attractive option for several reasons. In addition to greatly speeding testing (as very few surveys will run longer than the TOVA, let alone a complete set of attention tasks) it would enable measuring attention online – an increasingly important factor given the growth in online testing using platforms like Mechanical Turk. This could extend the reach of attention research beyond the typical 'WEIRD' participants (Henrich, Heine, & Norenzayan, 2010).

A search of the literature, however, revealed only two scales specifically designed to measure attention; both as a diagnostic tool by clinicians (Whyte et al., 2003) and psychologists (Kessler et al., 2005). These scales are designed and optimized for classifying people into diagnostic categories rather than accurately measuring across the non-pathological range as is required for psychometric work.

There are, in addition, scales that overlap attention to some extent, like the Cognitive Failure Questionnaire (Broadbent, Cooper, FitzGerald, & Parkes, 1982), which focuses on lapses in memory, action and perception, but none that seem designed to assess attention in detail in the general population.

Aims and Objective

The focus of this paper is to develop and test a subjective attention scale (SAS) – wherein people assess their own attentional abilities. The scale's psychometric properties and factor structure will be assessed to see if it is capturing attention in meaningful ways. Then, the scale will be compared to direct measures of attentional abilities from a range of laboratory tests of attention in order to determine whether people's understanding of their own attention matches what is being measured in current testing regimes.

Method

Participants

The subjective attention scale (SAS) was included in a large study examining relationships between susceptibility to decision making biases and a wide variety of individual traits (including attention, cognitive, personality and decision styles) being conducted under ARC Grant LP160101460. In total 301 participants completed the study (120M, 172F and 9 non-binary or did not say), ranging in age from 18 to 79 (mean = 28.7, SD =12.8). Most participants were native English speakers (n=207) and students/graduates (undergrads=107; bachelor-level graduates=84; post-grads=38; higher degree graduates=26; and vocational qualifications=20) with only 26 participants without any post-secondary study. Participants received a $100 gift card for participating in the study as a whole.

Materials

Subjective Attention Scale (SAS)

Fifteen statements were written for this measure; three corresponding to each of the five types of attention proposed by Sohlberg and Mateer (1989): focussed; sustained; selective; alternating and divided. Each set of three included one reverse-scored statement as shown in Table 1.

The preamble to the scale asked participants to indicate how strongly they agreed that the statement described them (typically rather than at time of testing) on a 1-5, Strongly Disagree to Strongly Agree scale. Scores were summed across all questions to yield a 15-75 score, with higher values indicating a better subjective assessment of attention.

Attention Tasks

Six tasks were designed in Matlab to enable measurement of participants' attention, guided by Sohlberg and Mateer's (1989) proposed division but using variants of established tests of attention and metacognition.

Focused Attention. Simple reaction time tasks are argued to correlate with intelligence *because* of greater attentional control – allowing a person to focus and avoid distractions while waiting to respond (see, e.g., Sheppard & Vernon, 2008). This task asked participants to respond by pressing the space bar as soon as a red letter R (for 'respond') appeared on the computer screen - replacing a black W ('wait'). The participant was first prompted to press the space bar when they were ready for a trial to begin. After this, the target appeared after a random period of time between 1.5 and 3.5 seconds and the time between its appearance and the participant pressing the space bar was measured. (NB - pressing the key before the stimulus appeared reset the timer and was recorded as a 'false start'.) The participant's median reaction time from ten trials was recorded as a measure of their *focused attention*.

Table 1. Subjective attention scale items

Q	Statement (Code)
1	I am better than most people I know at searching for objects or information. F1
2	I have a longer attention span than most people I know. C1
3	I am more easily distracted than most people I know. S3r
4	I can switch back and forth between different tasks more quickly than most people I know. A1
5	I lose concentration more easily than other people I know. C3r
6	When focussing on a task, I can ignore distractions more easily than most people I know. S1
7	I am better at multi-tasking than most people I know. D1
8	I notice details that most people I know would miss. F2
9	I find it harder to switch between tasks than most people I know. A3r
10	I have better attention to detail than most people I know. C2
11	When reading, I do not notice distractions like music or others talking as much as most people I know. S2
12	I am less aware of my surroundings than most people I know. F3r
13	When switching between tasks my performance suffers less than most people I know. A2
14	Focussing on multiple tasks at once is more difficult for me than most people I know. D3r
15	I can continue working while carrying on a conversation more easily than most people I know. D2

Note: F = focused, C = sustained (concentration), S = selective, A = alternating, D = divided, with three of each type and 'r' indicating a reverse-scored question.

Sustained Attention. Participants were presented with a string of 100 pseudo-randomly distributed letters (from A-J) and asked to respond (pressing the space bar) only to the letter 'E' – that is sustaining attention in readiness for a rare and unpredictable response (Sarter, Givens, & Bruno, 2001). Each letter remained visible for 1 seconds – allowing no more than this amount of time for a reaction. The measures of *sustained attention* were: the median response time across correct responses; and the number of errors of commission (responding to a non-target trial).

Selective Attention. A flanker task (Eriksen & Eriksen, 1974), showing a left or right facing chevron (< or >) in the centre of the screen surrounded by either congruent (e.g., <<<<<), neutral (e.g, 00<00) or incongruent (e.g., >><>>) flanking characters. Participant were asked to press the key corresponding only to the central character for each of 120 trials (40 of each sort, pseudo-randomly distributed). Each stimulus remained on screen for 1 second before disappearing. The next stimulus appeared 0.3 seconds after that. Measures were the median response time and number of correct responses for each of the three different stimulus types (congruent, etc). The differences between response times and number of errors on congruent and incongruent trials were derived as measures of *selective attention*.

Alternating Attention. Two trail making tests (Reitan, 1958) were designed – a numerical one in which participants had to use the touchscreen to connect 25 numbers (1-25) in order and an alternating, alphanumeric one in which an ascending number then letter pattern was used (i.e. 1-A-2-B-3-C-etc). (Each was also preceded by a practice test.) The tests were isomorphic reflections so the path length was identical and the starting point was near the centre of the screen to prevent differences in scanning time. Participants' times to complete and the number of errors they made (which caused a flash and a beep to let them know their response was out of order) were recorded for each sub-test with the differences between these used to derive measures of *alternating attention*.

Divided Attention. This task displayed coloured (Red, Blue, Green or Yellow) numbers (1-8), one at a time for 1.5 seconds each and participants were asked to respond only to Odd Blue and Even Red numbers – requiring them to assess stimuli on two rules simultaneously (i.e. dividing their attention; Miller, 1982). Each participant saw 96 trials, of which 24 were target stimuli (12 odd, blue numbers and 12 even red). The measures recorded for *divided attention* were median response time across correct responses, number of correct responses and number of errors of commission.

Inhibition. While not fitting within the Sohlberg and Mateer framework, inhibition was included as a commonly used laboratory measure of attention. A task similar to the SART (the misnamed sustained attention to response task; Warm, 1984) was designed, which showed participants 100 trials – each consisting of a single digit (0-9) displayed for one second. Participants were asked to respond as fast as they could to all stimuli except 3s –resulting in fast, automatic responses that need to be occasionally inhibited. Their median response time and number of errors of commission were recorded as the measures of *inhibition*.

Procedure

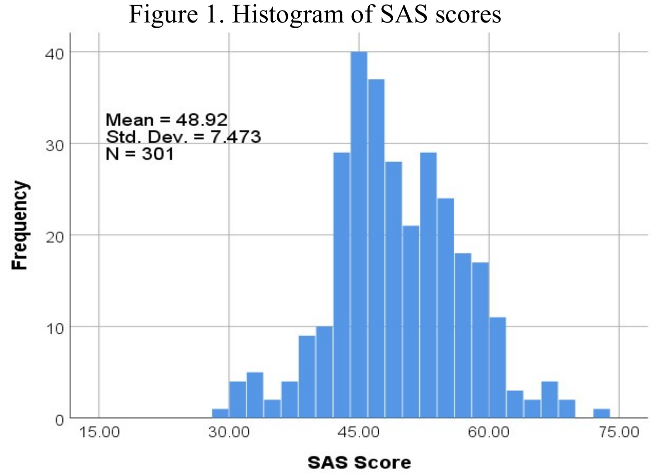
As noted above, participants were engaged in a larger study – too large to describe in detail here. In brief, it included two online studies, the first including a full, 5-factor personality test, several decision style measures and the Subjective Attention Scale. A second, online study included measures of intelligence, confidence and bias susceptibility measures before participants were invited to the laboratory for an additional 2.5 hours of intelligence testing and decision bias testing. The attention tasks described herein were included as a block within this session in between the bias tasks in the following order: *focused, sustained, inhibition, selective, alternating* and *divided*.

Results

Subjective Attention Scale (SAS)

Participants' mean score on the SAS was 48.9 (SD = 7.5) and the distribution of their scores (ranging from 29 to 72) is shown in Figure 1.

Figure 1. Histogram of SAS scores



Psychometric Properties

Cronbach's α was calculated at 0.804, indicating the scale items measure the same underlying trait to an acceptable level. Examination of results indicated that removing question 12 (F3r) would improve this slightly to .808. Given the scale deliberately included items aimed at different aspects of attention, however, no questions were removed and a factor analysis was conducted to determine whether any structure within the scale matched the theoretical basis.

Exploratory Principal Axis Factoring (PAF) was conducted in SPSS using Oblimin rotation with Kaiser normalization. The Kaiser-Myer-Olkin measure of sampling adequacy was 0.792 and the Bartlett's test of sphericity was significant, $\chi^2(105) = 1398$, $p < .001$. Communalities for the fifteen questions averaged 0.469, ranging from 0.181 to 0.727. Overall, these results were adjudged supportive of factor analysis. The PAF converged after 15 iterations, extracting four factors (eigenvalues > 1; supported by examination of the scree plot) explaining ~47% of the variance. The pattern matrix is shown as Table 2.

Looking at the factor loadings, factor 1 seems to reflect people's belief in their *multitasking* ability – with all three questions from both the divided attention and alternating attention question subsets loading on it. Factor two seems to be measure of *distractibility* – with four questions from the sustained attention (concentration) and selective attention subsets loading negatively on it. Factor three can be described as *focus*, with all three of the focused attention and the remaining sustained attention/concentration question (asking about attention to detail) loading on it. Factor 4 is more difficult to categorise as two of its questions (6 and 12) also load on other factors, leaving only question 11 as unique. Looking at the three questions, their shared characteristic seems to be awareness of one's surroundings. This has tentatively been labelled *awareness* – while recognising that the distinction between this, *distractibility* and *focus* is weak.

While these do not clearly map onto the five, theorized types of attention these seemed reasonable factors and were used with the overall SAS scale in the following analyses.

Table 2. Pattern matrix showing factor loadings above 0.3

Q	Q Type	1	2	3	4
4	Alternating	.739			
9	Alternating	.720			
14	Divided	.700			
7	Divided	.689			
13	Alternating	.418			
15	Divided	.408			
3	Selective		-.876		
5	Concentration*		-.860		
2	Concentration*		-.664		
6	Selective		-.462		.339
8	Focused			.792	
10	Concentration*			.636	
1	Focused			.303	
11	Selective				.452
12	Focused			.359	-.368

Note: 1) Multitasking; 2) Distractibility; 3) Focus; and 4) Awareness. * Concentration = Sustained attention.

Subjective vs Objective Measurement of Attention

Descriptive statistics from the SAS and laboratory attention task measures are shown in Table 3. Looking at the table, one sees expected patterns, with both response times and error rates increasing with the complexity of the task (NB: *selective* and *alternating* measures are differences between response times in different task conditions and are not directly comparable to the other RT measures.)

In order to examine the relationships between subjective and measured aspects of attention, correlations were calculated between the SAS, its five factors, the attention task measures from Table 3 (excepting error measures from simpler tasks where the median number of errors was zero) plus three additional measures reflecting the difference between a person's simple reaction time and their reaction time measured on the more complex tasks. Table 4 shows the part of the correlation matrix relevant to this discussion.

Table 3. Descriptive statistics

Measure		N	Mean	SD
Subjective Attention	(SAS)	301	41.1	7.5
Focused RT	(F_RT)	299*	0.334	0.073
Focused Errors	(F_E)		0.440	0.962
Sustained RT	(Su_RT)	301	0.438	0.045
Sustained Errors	(Su_E)		0.400	0.902
Inhibition RT	(I_RT)	301	0.372	0.075
Inhibition Err	(I_E)		3.05	1.887
Selective ΔRT	(Se_RT)	259**	-0.075	0.055
Selective ΔCorrect	(Se_dC)		3.63	5.728
Alternating ΔRT	(A_RT)	301	17.24	24.38
Alternating ΔErrors	(A_E)		0.70	7.482
Divided RT	(D_RT)	301	0.822	0.129
Divided Correct	(D_C)		21.23	2.87
Divided Errors	(D_E)		5.04	3.97

Note: RT values are in seconds; errors are errors of commission – e.g., false starts and responding to incorrect stimuli. Correct responses were recorded for the Divided Attention Correct measure – elsewhere this was irrelevant as almost all participants correctly responded to target stimuli. Δ indicates measures calculated as differences between two other scores from a task. * - two participants were removed from the Focus task results having made 81 and 594 false starts in the 10-trial reaction time task. ** - a problem with the task used to assess selective attention led to a number of early participants producing no useable data for this test.

Table 4. Correlations between subjective and laboratory measures of attention

	SAS	F1	F2	F3	F4
F_RT	-.020	-.051	-.064	-.058	.045
Su_RT	-.096	**-.127**	-.037	**-.132**	-.005
I_RT	.018	-.064	-.094	.018	.010
I_E	-.034	.083	.085	-.111	-.013
Se_RT	.026	.033	-.032	.024	-.000
Se_dC	-.008	-.020	-.017	-.032	.046
A_RT	-.003	-.025	-.060	-.020	-.063
D_RT	.032	-.009	-.041	.017	.059
D_C	.089	.083	-.051	**.118**	.042
D_E	.033	.002	.001	.015	-.003
S - F	-.070	-.050	.061	-.061	-.013
I - F	.011	-.022	-.013	.031	.001
D - F	.030	.010	.002	.032	.054

Note: **bold** values are significant at the .05 level, two-tailed. Correlations are shown without family-wise corrections to enable easier viewing of any patterns or trends in the data. With a Bonferroni correction for the 65 comparisons, none of the results reach significance.

Looking at the table, it is clear the Subjective Attention Scale does a very poor job of predicting people's performance on the attention measures and none of the four factors do much better. Only three correlations in the table are significant and then only because the family-wise alpha level has not been adjusted. (Analyses also confirmed this was not caused by the inclusion of non-native English speakers - as their removal did not change the results.)

The laboratory attention tasks, by comparison, are related to one another in sensible ways as shown in Table 5. Here, one sees five of the six measures recording responding time correlating positively, the exception being the Selective attention task (with which problems were noted during data collection) and the fact that Alternating attention correlates with the others suggests there is more to this than all of the measures being reliant on speed of responding, as this measure removes individual differences in response time by comparing the same participant on equivalent tasks.

Table 5. Correlations between laboratory measures of attention

	1. F_RT	2. Su_RT	3. I_RT	4. D_RT	5. Se_RT	6. A_dT	7. I_E	8. D_E	9. Se_dC
1	1								
2	**.518**	1							
3	**.200**	**.133**	1						
4	**.282**	**.374**	**.160**	1					
5	-.044	.054	-.055	-.094	1				
6	**.166**	**.157**	**.211**	.108	-.089	1			
7	-.077	.024	**-.613**	-.037	-.07	-.095	1		
8	.017	.104	-.087	-.03	-.099	**.167**	**.192**	1	
9	-.009	.075	**-.252**	.038	-.025	.011	**.163**	**.193**	1

Note: **bold** entries are significant at the .05 level. Correlations above are shown without family-wise corrections to enable easier viewing of patterns or trends in the data. With a Bonferroni correction for the 36 comparisons, correlations above 0.184 remain significant (0.185 for F_RT and 0.198 for Se_RT given smaller Ns) at the .05 level, two-tailed.

Similarly, there are positive correlations between the three accuracy/error measures included in the table, indicating that people prone to making mistakes in one test were likewise inclined in the others. Finally, there is some evidence of a speed/accuracy tradeoff in participants' performance on the inhibition task, with people responding faster on this task being more inclined to make errors not just on this task but also on the selective attention task.

Other covariates

Given the lack of any significant relationship between the subjective attention scale (SAS) and the laboratory attention measures, additional analyses were conducted using measures collected as part of the larger study.

Twenty direct measures of cognitive ability and a subjective numeracy scale (Fagerlin et al., 2007) were included in the larger survey. Correlations between the SAS and these twenty-one component tests revealed a single significant correlation – between participants' subjective numeracy and the SAS, $r(299) = -.266$, $p<.001$. That is, people who regarded themselves as being less numerate saw themselves as having better attention. Correlations with the SAS factors revealed this held across all four factors and the only other observation was that Factor 3 (Focus) had three weak ($\leq .124$) negative correlations with cognitive measures - the CAB-I and the Letter-Pattern and Visualization tasks from the Woodcock-Johnson IV (Hakstian & Bennet, 1977; Schrank et al., 2015) - reach significance at the .05 level (again, without correction for family-wise alpha).

(By comparison, cognitive measures had many significant relationships with attention measures – supporting the idea that intelligence affects/is affected by attention. Being peripheral to this paper, these analyses have been excluded.)

By contrast, Table 6 shows correlations between the SAS, its factors and the Big Five personality traits from the NEO PI-3 (Costa & McCrae, 2010), showing a number of significant relationships. A quick summary of results indicates weak tendencies for: more neurotic people to regard themselves as more distractible; more extraverted people to regard themselves as better at multitasking; more open people as being more focused; and more agreeable people as being worse at multi-tasking and having less awareness.

Table 6. Correlations between SAS and personality traits

	SAS	F1	F2	F3	F4
Neuroticism	**-.174**	*-.125*	***.289***	.053	-.108
Extraversion	*.120*	**.235**	.083	.060	.088
Openness	*.127*	.097	-.023	***.246***	-.096
Agreeableness	**-.150**	**-.153**	.086	-.069	*-.145*
Conscientiousness	***.481***	***.280***	***-.462***	***.391***	.090

Note: results in *italics* are significant at the .05 level, in **bold** at the .01 level and ***italic bold*** at or below .001. Correlations above are shown without family-wise corrections to enable easier viewing of patterns or trends in the data. With a Bonferroni correction for the 25 comparisons, correlations at or above 0.178 are significant at the .05 level, 0.203 at the .01 level and 0.235 at the .001 level.

Finally, the SAS and three of its factors correlate most strongly with conscientiousness, indicating that more conscientious people regard themselves as better at multi-tasking and focus while being less distractible. This suggests people's subjective opinions of their own attentional ability may be grounded in facets of conscientiousness such as self-discipline, achievement striving and orderliness rather than in cognitive and metacognitive abilities.

Discussion

The stated aim of this paper was not achieved. The subjective attention scale, while showing decent psychometric properties and having the potential to improve on these through refinement of the included questions, did not predict people's performance on the types of tasks commonly used to assess people's attentional abilities.

This 'strength' of this negative finding is interesting in its own right, suggesting people have very little insight into how their own attentional capabilities compare to others. As noted earlier, the attention measures correlated with one another (and with cognitive ability measures) indicating stable individual differences but participants appear not to be meaningfully aware of these abilities – whether as a result of something like a Dunning-Kruger effect (Kruger & Dunning, 1999) or their operating at subconscious levels.

Rather, their perceptions of their attentional abilities are associated with their personality traits - conscientiousness in particular. This poses an interesting question about the relationship of conscientiousness to attention. Several facets of conscientiousness *sound* like they measure attention-adjacent things like self-discipline: focusing on specific tasks and ignoring unwanted stimuli. If the results seen here result from a correspondence between subjective attention and such aspects of conscientiousness, this suggests that people's self-rated conscientiousness might also be a poor predictor of their actual ability to attend in laboratory tasks, although this would require further research.

Caveats and Future Research

One caveat relates to the choice of types of attention for inclusion in the scale. As noted, five were selected and three questions written for each. The scale, however, included no questions on *inhibition* as this was not included in Sohlberg and Mateer (1989). The fact that a laboratory task designed to assess this measure did not significant correlate with the overall SAS scale is, thus, not particularly surprising. Future work on subjective attention should, therefore, incorporate questions directly relating to people's ability to inhibit automatic responses, which may allow greater insight into how *inhibition* relates to other attention measures as well.

Additional concerns might be raised regarding the items developed for the scale in terms of their number and contents. The former has implications for the factor analysis and, in particular, the fourth factor, which has only three items load on it at relatively low levels. Similarly, whether the scale items and laboratory tasks were optimally matched could also be questioned. The SAS was intended as a preliminary attempt at developing a subjective attention scale (as a sideline to a larger project) which could inform future, more detailed work. Any flaws in the scale resulting from its limitations, however, seem insufficient to explain the complete lack of any relationships between the scale, its factors and the laboratory tasks of attention – particularly in light of its adequate psychometric properties.

In terms of future research, two approaches that might yield results are: to examine the laboratory tasks for latent variables to then link to current or future survey items; or undertaking a finer grained analysis of how different cognitive and personality traits relate to the laboratory attention tasks, which could shed light on the nature of attention as captured by these tasks and whether there are aspects of attention captured by conscientiousness, for example, that are not currently incorporated into laboratory tasks.

Conclusions

While the subjective attention scale developed herein captured aspects of personality (most specifically, conscientiousness) that *seem* related to attention, it did not predict performance on laboratory measures of attention and was unrelated to cognitive abilities that have previously been linked to attention, suggesting a mismatch between people's attentional abilities and their metaknowledge regarding those abilities. In short, rather than a test of attention, the SAS seems to be measuring conscientiousness and despite the apparent links between conscientiousness and attention, no relationship between them was demonstrated herein.

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