Original Article

An Item-Level Evaluation of the Attentional Style Questionnaire (ASQ) Using a Sample of Experienced Cyclists

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Abstract. Effective attentional control is crucial for safe urban cycling. The Attentional Style Questionnaire (ASQ) assesses orientation of attention and its underpinning processes. This study contributes to the ASQ literature by detecting intraindividual and interindividual item response patterns in a group of cyclists to derive a parsimonious context-specific version of the ASQ. We performed a multidimensional item response theory analysis of Internal and External Distraction Control scales of the ASQ using data from experienced road cyclists, fitting both constrained and unconstrained graded response models to the data; we also examined person fit. Five of the original 17 items were discarded due to low factor coefficients and item discrimination parameters. The remaining items exhibited good psychometric properties including high discrimination parameters and category utilization. Only two and five people exhibited person misfit for Internal and External Distraction Control scales, respectively. This abbreviated ASQ may be appropriate for assessing cyclists' attentional control.

Keywords: attention, cycling, distraction, questionnaire, safety

Researchers have conceptualized attention in a myriad of ways – sometimes erroneously (Hommel et al., 2019). However, most concepts incorporate the notions of top-down and bottom-up attentional processing. Top-down attention describes goal-directed, controlled attentional processes, whereas bottom-up attention is characterized by reflexive orienting of attention toward novel, salient, and unexpected stimuli, even when they are irrelevant to an ongoing primary task (Corbetta & Shulman, 2002). Research has shown that, even when top-down attentional demands are high – for example, under dual task conditions – bottom-up attentional capture still occurs, even across modalities (Salo et al., 2017). It is important to understand the complex interplay between top-down and bottom-up processes if we want to predict the causes and consequences of (in)effective attention allocation in dynamic real-world environments, such as those encountered during urban cycling.

Numerous researchers have developed measures to assess individuals' attentional control in relation to, inter alia, sport performance (Test of Attentional and Interpersonal Style [TAIS]; Nideffer, 1976), psychopathology (Attentional Control Scale [ACS]; Derryberry & Reed, 2002), well-being (Mindful Attention Awareness Scale [MAAS]; Brown & Ryan, 2003), and healthy emotionality (Emotional Style Questionnaire [ESQ]; Kesebir et al., 2019). The variety of these measures reflects not only the breadth of the attention construct but also the variety of contexts in which it has been examined. However, a common theme in these measures is distraction. For example, the TAIS identifies when individuals are prone to external distraction, exhibiting a tendency toward what Nideffer (1976) described as a *broad external* focus; the ACS comprises an *attentional focusing* subscale, with items that describe both external and internal distractions; the MAAS aims to determine individuals' ability to stay aware of their current actions, rather than performing them distractedly; and the ESQ explicitly refers to distraction in two of the four items on its attention subscale.

Van Calster et al. (2018) developed the Attentional Style Questionnaire (ASQ) by combining items from the Tellegen Absorption Scale (Tellegen & Atkinson, 1974) and the Encoding Style Questionnaire (Billieux et al., 2009) with items relating to both top-down and bottom-up attentional controls and internal and external orientations of attention. After exploratory factor analysis (EFA), five items were excluded to

yield a 12-item version comprising seven items relating to control of internally directed attentional control and five items to externally directed control; confirmatory factor analysis (CFA) showed the model to have adequate fit (RMSEA = .08; SRMR = .08; CFI = .89). However, according to Hu and Bentler (1998), the CFI value indicates less than good model fit. Moreover, a simple 2-factor model such as this should have a lower RMSEA for good model fit. The internal consistency values were less than 0.8, indicating just adequate but less than good reliability. Finally, the CFA model used in this study employed maximum likelihood and did not correct for the Likert scale of the items. This could lead to inaccurate estimates (Natesan, 2015). In sum, this is an indication that more work needs to be conducted on these scales. However, as the authors noted, the ASQ is a novel addition to existing attentional control measures because it accounts for internal bottom-up attentional capture (e.g., intrusive thoughts); exogenous stimuli have typically been examined in this regard (e.g., Mast et al., 2017).

Recently, Kraft et al. (2020) used EFA and CFA to examine the factor structure and validity of the ASQ, using an English-speaking sample; they also determined its ability to predict anxiety-related psychopathology. In their first study, 286 participants completed the original 17-item version of the ASQ. The best-fit solution comprised a total of 15 items, which represented two independent factors, which the authors termed *Distractability/Cognitive Avoidance* and *Focusing*. The item composition of these factors overlaps strongly with the bottom-up oriented and top-down oriented items originally identified by Van Calster et al. (2018).

In a second study, 227 participants completed the original ASQ (Van Calster et al., 2018), along with a range of established measures of attentional control and anxiety-related psychopathology. Distractability/Cognitive Avoidance correlated negatively with attentional control, as measured by the ACS (Derryberry & Reed, 2002), and positively with anxiety, avoidance, perseverative thinking, rumination, and worry; converse relationships emerged for the Focusing factor. CFA confirmed the original ASQ factor structure, albeit weakly, and regression analyses showed that Distractability/Cognitive Avoidance subscale scores could predict psychopathology, whereas Focusing subscale scores did not. The above findings suggest that the ASQ is a potentially useful measure of attentional control – although the optimal factor structure and item composition are indeterminate.

Urban cycling is attentionally demanding, requiring rapid alternation between external and internal orientation of attention, as well as between bottom-up and top-down processing – for example, to detect emergent hazards then respond to them appropriately; failure to do so is one of the primary determinants of cycling-related accidents (Fotios & Castleton, 2017; Melin et al., 2018). External distractions are commonplace in urban cycling (Useche, Alonso, et al., 2018), particularly auditory ones (Wolfe et al., 2016), and older adults may be more distractible than other age groups (Useche et al., 2019). Moreover, personality traits have been shown to predict cyclists' behavior. For example, O'Hern et al. (2020) administered the Big Five Inventory (John & Srivastava, 1999) to 615 Australian cyclists and found positive associations between extraversion and cycling errors and violations; agreeableness and conscientiousness had negative relationships with these transgressions.

Cycling improves adults' cognitive function (Varela et al., 2018), and there are additional benefits when cycling outdoors (Leyland et al., 2019). If we are to improve adult cyclists' road safety, then it is important to assess their ability to deal effectively not only with external distractions but also internal ones. While the ASQ appears to be an appropriate tool for assessing individual differences in cyclists' attentional control, it has hitherto been scrutinized only at the factor level using a factor analytic approach. Moreover, the CFA in the study by Van Calster et al (2018) did not use the appropriate corrections for Likert-type data and had less than good model fit. Although CFA provides an overall picture of the scale structure, we still need more psychometric information such as item-level and person-level parameters and fit indices to fully understand the performance of the instrument. Therefore, it is necessary to analyze the instrument in greater depth using item response theory analyses to understand the characteristics of items on each scale, for example, whether the items elicit inconsistent, aberrant, or misfitting response patterns from participants; whether the instrument can be further shortened to yield a more efficient instrument; and whether more items are needed to measure the latent traits (in this case, External and Internal Distraction Controls). Accordingly, the aim of this study was to perform an item-level analysis of the original 17-item version ASQ (Van Calster et al., 2018), using data collected from a sample of experienced UK road cyclists. Person fit analyses were also conducted to examine if the response pattern matched what was expected from a participant at a particular latent trait level.

We report how we determined our sample size, all data exclusions (if any), all data inclusion/exclusion criteria, whether inclusion/exclusion criteria were established prior to data analysis, all measures in the study, and all analyses including all tested models.

Method

Participants

Participants were 191 cyclists recruited via a survey distributed via UK cycling clubs and online fora; this sample

Table 1. Cycling experience of the sample

	Average miles cycled per week over preceding year						
Years of urban road cycling experience	1–10	11–20	21–30	31–40	41–50	51+	Total
1–5	4	3	2	2	2	2	15
6–10	2	2	3	1	2	9	19
11–15	1	1	5	1	2	7	17
16–20	1	1	2	2	1	9	16
21–25	2	1	—	4	3	5	15
26–30	—	—	1	2	3	2	8
31+	2	5	17	13	8	56	101
Total	12	13	30	25	21	90	191

Table 2. Retained ASQ items (original item number in parentheses)

External distraction control	Internal distraction control
I have trouble concentrating when there is movement in the room I am in (1)	In general, I stay in control of my thoughts and do not let myself get distracted by interfering thoughts (2)
I am easily drawn to new stimuli (for example, voices of people passing by, a sound in the house . . .) that are not relevant to a task I am doing (3)	It is hard for me to stay on one activity for a whole hour (7)
I can easily ignore my surroundings (11)	During an activity, unrelated mental images and thoughts come to my mind (8)
I can easily concentrate on a task, even when there is movement in the room I am in (14)	I often put hold to an activity, because I think of another one I have to start or continue (9)
I have trouble thinking when there are noises, even if these noises are not intense (16)	I generally stay focused on a single task until it is finished (10)
	Sometimes I interrupt an activity to check an unrelated detail (12)
	When I am working on my computer, I often go to the Internet to visit websites that are unrelated to my work (13)

size was determined by the number of complete survey responses received. No inclusion or exclusion criteria were applied; hence, no cases were excluded. The sample was primarily male (81%), and ages ranged from 18 to 80 years (M = 57.03 years, SD = 13.97 years). Ninety-seven percent of the sample had normal or corrected-to-normal vision, and 97.0% had normal or corrected-to-normal hearing. The White UK ethnic group comprised 98.0% of the sample; the remaining ethnicities comprised Asian British (n = 1), Black British (n = 2), and Hispanic (n = 1) individuals. Seventy percent of the sample belonged to a cycling club. 53.4% of the sample had undergone formalized cycle training, at either beginner (37.7%), intermediate (4.71%), or advanced (11.0%) levels. Table 1 summarizes the sample's cycling experience.

Measures

An English version of the original 17-item ASQ (Van Calster et al., 2018) was distributed to participants as part of a larger cycling-related survey administered using online survey software (Qualtrics, 2020).

Statistical Analyses

A multidimensional item response theory (MIRT, Reckase, 2009) model was fit to the data with a hypothesized two-factor structure as illustrated in Table 2. We labeled the two factors, *External Distraction Control* and *Internal Distraction Control*, comparable to the distinction proposed by Van Calster et al. The R package mirt (Chalmers, 2012) was used to fit the MIRT model in R (R Core Team, 2020). We used the graded response model (GRM, Samejima, 1969) for each factor within the MIRT model because the item categories have a meaningful increasing order, and we wanted to allow the items to have discrimination parameters. Allowing discrimination parameters to vary across items also mimics the factor analytic model: The discrimination parameters are the IRT equivalent of factor coefficients. Both constrained and unconstrained GRMs were fitted to the data. A constrained GRM constrains the item discrimination parameter to be the same across all items that indicate a latent trait (scale) while an unconstrained GRM allows the item discrimination parameters to be

Table 3. Factor coefficients from the MIRT models

	All items model			12 items model		
Item number	F1	F2	h2	F1	F2	h2
1	.80	.00	.64	.80	.00	.65
16	.79	.00	.62	.78	.00	.60
12	.00	.68	.46	.00	.70	.49
3	.72	.00	.52	.73	.00	.53
13	.00	.59	.35	.00	.61	.37
8	.00	.61	.37	.00	.62	.39
9	.00	.70	.49	.00	.71	.50
7	.00	.74	.54	.00	.73	.54
17	.05	.00	.00			
4	.12	.00	.01			
6	−.24	.00	.06			
2	.00	−.72	.52	.00	−.71	.50
10	.00	−.75	.56	.00	−.74	.54
5	−.04	.00	.00			
14	−.78	.00	.61	−.78	.00	.61
15	.00	−.27	.07			
11	−.52	.00	.27	−.52	.00	.27

freely estimated across the items. Items were flagged for further consideration if (a) the category response curve (CRC) peak for any response category in the item fell under another CRC throughout the entire latent trait space – this meant that not all of the six response category options were utilized by participants – or (b) the discrimination parameter of the item was < 0.65 (Baker et al., 2001). Furthermore, Emons's (2008) polytomous extension of van der Flier's (1980, 1982) U3 statistic was computed to detect inconsistent, aberrant, or misfitting patterns of item scores using the package PerFit (Tendeiro et al., 2016).

Results

An MIRT model with the specified two-factor structure indicated that five items had very small absolute values of discrimination parameters (less than 0.3) and absolute values of factor coefficients (less than .20); discrimination parameters and factor coefficients are the counterparts of IRT and factor analytic models, respectively. These were Items 4, 5, 6, 15, and 17, two of which (4, 5) are very similarly worded (e.g., "I can be so absorbed in a train of thought that I become unaware of my surroundings" and "When I am doing a task, I am often so focused I do not notice my surroundings"). The model fit indices for this model were M2 statistic of 190 ($df = 51$, $p < .05$), RMSEA of .12, and a CFI of .91.

Therefore, these items were discarded, and a MIRT model was again fit to the remaining 12 items with the factor structure intact. The second iteration of the MIRT model (i.e., with the 12 items) had absolute values of factor coefficients all greater than .50 (Table 3). The model fit indices for this model were M2 statistic of 16.45 ($df = 6$, $p < .05$), RMSEA of .09, and a CFI of .99 indicating a much better fit than the 17-item MIRT model. The absolute values of factor coefficients of the 12-item 2-factor model which allowed correlation between factors were all greater than .50. This shows evidence of convergent validity (high factor loadings) and but low evidence of discriminant validity (correlation between factors = .68). Models where the factors were orthogonal to each other did not fit the data as well with RMSEA and SRMR much higher than the cutoff. Unconstrained GRMs fit better than the constrained GRMs for both factors (ΔAIC = 583 and ΔBIC = 564 for Internal Distraction Controls, ΔAIC = 437 and ΔBIC = 424 for External Distraction Controls). Additionally, the absolute values of item discrimination parameters ranged from 1.3 to 2.3 for Internal Distraction Controls and .90 to 3.01 for External Distraction Controls as shown in Table 4.

Internal Distraction Control

Ordinal Cronbach α and ordinal omega for the Internal Distraction Control scale were .82 and .86, respectively. The item and test information, and category response curves for Internal Distraction Control are given in Figures 1 and 2, respectively. All items had sufficient discrimination parameters. In Table 4, some of these discrimination parameters are negative because these items are reverse scored; however, this does not affect model fit or interpretation. Maximum information about the scale (90.13%) was contained between a latent trait value of −3 and 4, which shows that the scale captures adequate information across various levels of Internal Distraction Control. Items 8, 12, and 13 had one category that was unutilized, as can be seen from one category response curve in each item that is suppressed by the other curves. Therefore, this indicates that simply having five response categories for these items might have yielded the same information as six categories. However, we do not know if such a pattern would remain the same for other groups. Only two people showed person misfit: Both individuals chose extreme response patterns at one end for some items and extreme response patterns on the other end for other items on the scale.

Table 4. Item threshold and discrimination parameters from the 12-item Graded Response MIRT model

Item number	Threshold 1	Threshold 2	Threshold 3	Threshold 4	Threshold 5	Discrimination 95% CI
External Distraction Control Scale						
1	−0.819	0.324	0.788	2.013		3.010 [1.94, 4.05]
16	−1.080	0.046	0.611	1.911	3.345	2.320 [1.65, 3.01]
3	−2.244	−0.400	0.520	1.994	3.281	1.354 [0.94, 1.77]
11	4.180	2.486	0.462	−1.280	−3.471	−0.964 [−1.34, −0.60]
14	2.935	1.795	0.471	−0.480	−2.060	−2.079 [−2.69, −1.49]
Internal Distraction Control Scale						
12	−2.194	−0.918	−0.313	1.665	2.514	1.704 [1.21, 2.20]
13	−2.049	−0.361	0.220	1.494	2.664	1.437 [1.00, 1.86]
8	−1.819	−0.652	0.104	1.665	2.908	1.418 [1.00, 1.85]
9	−1.948	−0.621	0.189	1.558	3.070	1.831 [1.31, 2.36]
7	−0.927	0.243	1.075	1.980	3.381	1.738 [1.23, 2.26]
2	3.420	1.932	0.724	−0.390	−2.402	−1.519 [−1.98, −1.06]
10	2.799	1.684	0.614	−0.388	−1.889	−1.779 [−2.29, −1.27]

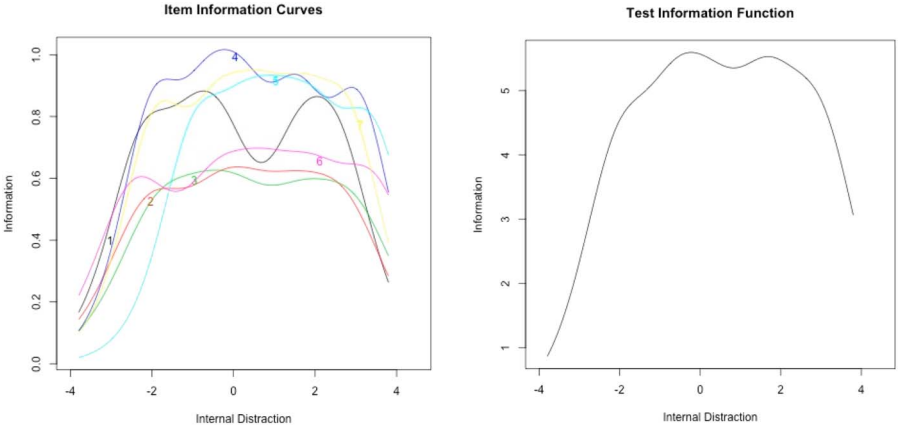

Figure 1. Item and test information curves for internal distraction control.

External Distraction Control

Ordinal Cronbach α and ordinal omega for the External Distraction Control scale were .79 and .85, respectively. The item and test information and category response curves for External Distraction Control are given in Figures 3 and 4, respectively. All items had sufficient discrimination parameters. In Table 3, some of these discrimination parameters are negative because these items are reverse scored. However, this does not affect model fit or interpretation. Maximum information about the scale (91.6%) was contained between a latent trait value of −3 and 4, which shows that the scale captures adequate information across various levels of External Distraction Control. Items 1, 3, and 16 had one category that was unutilized, as can be seen from one category response curve in each item that is suppressed by the other curves. Again, this indicates that simply having five response categories for these items might have yielded the same information as six categories. Five people showed person misfit. Again, these people chose extreme response patterns at one end for some items and extreme response patterns on the other end for other items on the scale.

Discussion

The current study extends psychometric investigations of the Attentional Style Questionnaire using the Item Response Theory (IRT) framework in a sample of experienced UK road cyclists. Like Van Calster et al. (2018), we found that five of the 17 items did not have adequate factor coefficients and, therefore, discrimination parameters. Four of these items were

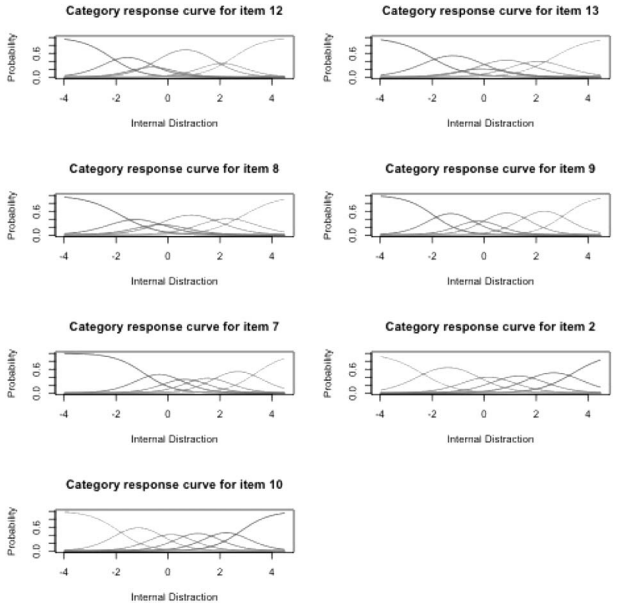

Figure 2. Category response curves for internal distraction control, by item.

the same as those in Van Calster et al.'s (2018) analysis. These items included Items (4) "I can be so absorbed by a line of thoughts that I become more or less unaware of my surroundings;" (5) "When I am doing a task, I am often so focused I do not notice my surroundings;" (15) "I can spend several minutes on a question and try to dissect it;" and Item (17) "I am often the first one to notice something has changed in a room." The other item we found as having low discrimination and therefore providing low information was item (6) "I do not have difficulty working while listening to music," whereas Van Calster et al. (2018) found item (3) "I am easily drawn to new stimuli (for example, voices of people passing by, a sound in the house . . .) that are not relevant to a task I am doing" to have a low factor coefficient.

Retaining the remaining 12 items, we found that all seven items in the Internal Distraction Control scale and all five items in the External Distraction Control scale contributed a substantial amount of information to the respective scales. In other words, all items were able to distinguish between participants with varying External Distraction Control or Internal Distraction Control latent trait levels; however, the third category remained unutilized (i.e., unendorsed) for three of the seven items in the Internal Distraction Control scale and for three of the five items in the External Distraction Control scale.

The Attentional Style Questionnaire abides with recommended practices of having 6/7 + response categories for optimal reliability, validity, and discriminating power (Preston & Colman, 2000). However, the results suggest that six of the items each had one category which was not utilized; these were all middle category responses – specifically, the third category. This suggests that people tend to favor choosing extremes rather than the middle category of three for these items. However, it is not clear whether removing one category just for these six items would be beneficial because it might confuse the participant to see different numbers of response categories for different items on the same measure. Therefore, the cost of confusion over varying number of response categories across different items that belong to the same scale outweighs the benefit of deleting one response category for each of these three items. Moreover, our analysis consisted of only one sample, and we cannot be certain that this would hold true for other samples. We did not examine any other constructs during our investigation.

Some other points are noteworthy. Both scales contained maximum information between −3 and 4 on the latent trait level. This indicates that both these scales provided maximum information for people with a wide range of Internal and External Distraction Control levels. Regarding person fit estimates, participants chose responses as expected for their latent trait levels except for two and five people for Internal and External Distraction Control scales, respectively. This represents a very small percentage of the respondents and does not warrant item modification. Given the prevalence of external distractions when cycling (Useche, Alonso, et al., 2018), the parsimony of the External Distraction Control subscale in the current version of the ASQ is particularly noteworthy: It comprises only five items, as four of those removed in the analysis belonged to this subscale, suggesting potential redundancy in the original ASQ items. Moreover, the remaining items refer to both visual and auditory distracters – both of which are prevalent in urban environments and influence cyclists' distractibility (Useche, Alonso, et al., 2018; Wolfe et al., 2016).

Limitations and Directions for Future Research

The results of the current study are applicable to a very specific demographic sample, that is, a sample of experienced cyclists. Future research should continue to examine the original scale in more diverse samples: Although Kraft et al.'s (2020) samples were *more heterogeneous* than Van Calster et al.'s, they were still predominantly Caucasian and/or female. Whether these results are particular to our sample or are more generalizable remains to be seen. Additionally, GRM usually requires sample sizes of at least 200 (Kieftenbeld & Natesan, 2012). In this regard, the sample size was slightly lower than this recommended sample size. It would be insightful for future studies with larger samples to examine differential item functioning (item bias) across clinically diverse samples.

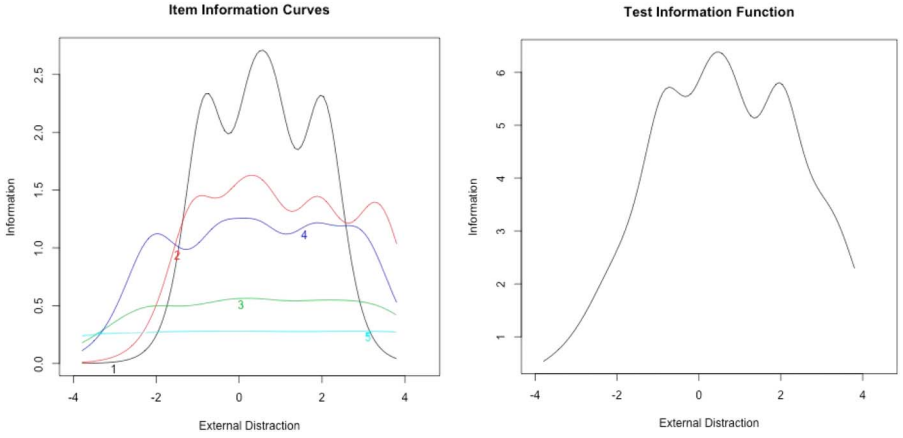

Figure 3. Item and test information curves for external distraction control.

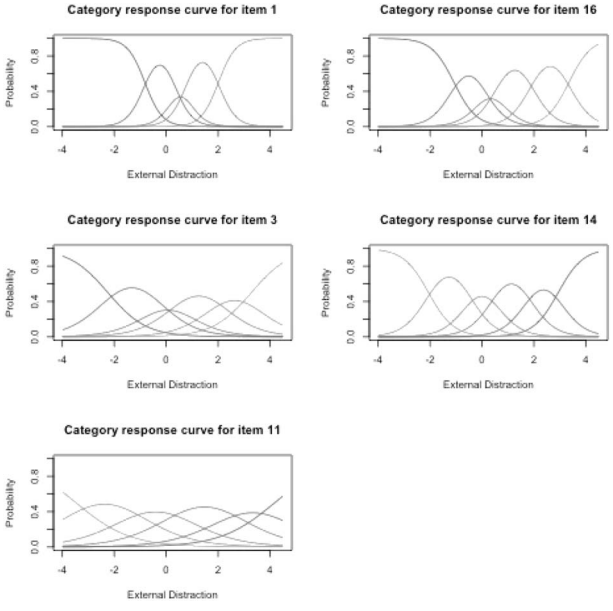

Figure 4. Category response curves for external distraction control, by item.

Despite these limitations, the results of the current study have important implications. Van Calster et al. (2018) identified the need for a clear distinction of internal and external attentional controls, and our analysis has delivered this. Broadly, the results indicate that all the retained items on the Internal and External Distraction Control items function well psychometrically. More specifically, this revised version of the ASQ may be viable for assessing individuals' ability to control their attention with respect to both internal and external distractions when on a bicycle and hence may enable us to better understand the contribution of individual differences to accidents, near misses, errors, and violations involving cyclists; further research is required to confirm this. This may be achieved by asking experienced cyclists to complete the revised ASQ, together with questions about their cycling behavior (e.g., violations, errors, positive behaviors; Useche, Montoro, et al., 2018) and negative experiences with other road users (e.g., near misses and accidents). Such work would allow us to further ascertain the validity and usefulness of the revised version of the ASQ for use with cyclist populations. This said, the original ASQ wording, which we retained in this revised version, limits the applicability to cyclists somewhat. Therefore, another step for future research will be to develop a version that comprises cycling-specific items; for example, "During an activity, unrelated mental images and thoughts come to my mind" could become "During *cycling*, unrelated mental images and thoughts come to my mind."

Although we acknowledge that Van Calster et al.'s (2018) identification of bottom-up and top-down processes in the original ASQ is an important inclusion, we should note that the external–internal distinction is perhaps more pertinent for assessing attentional control in cyclists relative to the general population or clinical populations, as they frequently navigate their way through environments that simultaneously exert high perceptual and cognitive demands. The rapid interplay between these two types of demands manifests unique attentional loads (see Lavie & Dalton, 2014) that do not typically arise in *everyday life* – which was Van Calster and colleagues' intended application for the original ASQ; such interactions also do not typically emerge in characterizations of psychopathology (Kraft et al., 2020).

Although the *Attention–Distractibility trait* (Forster & Lavie, 2016) has been portrayed as an undesirable one, it may confer an advantage in urban cycling. Hazards emerge at a rapid rate, their relevance changing as they do so. For example, a vehicle that emerges ponderously from a side road in the distance becomes task-relevant if it affects the cyclist's speed and trajectory, whereas the relevance of the same vehicle making a swift turn before safely accelerating

away from the cyclist diminishes incrementally until it becomes entirely task-irrelevant. Therefore, a cyclist who is prone to distraction by exogenous stimuli, irrespective of their initial task-relevance, may be more sensitive to changes in their external environment (cf. Nideffer, 1976) and therefore a better anticipator of upcoming hazards. A prudent direction for future investigation of urban cycling safety would be to explore the interaction of personality with perceptual load (as opposed to cognitive load; Lavie & Dalton, 2014). This may enlighten us as to the possible advantages, as opposed to disadvantages, of low External Distraction Control scores.

Conclusion

In conclusion, the aim of this study was to perform an item-level analysis of an English translation of the ASQ. A 12-item measure emerged, comprising two factors which assess respondents' ability to control internal and external distractions. We tentatively propose that this version may be particularly applicable to road cyclists and urban cycling contexts. We do acknowledge that the 12-item version was originally tested using the same sample as the final model fit analysis, and this can inflate the performance of the model. Therefore, we do not claim that this 12-item version is perfect, but the performance of the 12-item version should be investigated with a different sample to understand how truly a good measure the 12-item version is. However, given the context-specific nature of established measures of attentional control, a cycling-specific measure of attentional control would be a logical next step – one that is built on the revised ASQ presented here. Moreover, the present data relate only to adult cyclists – whose road cycling experience is inevitably greater than children's; hence, a child cyclist-specific measure would also be apposite. As global interest in bicycling for short journeys increases, so does the need to understand how cyclists can optimize their attentional control in complex and dynamic urban environments.

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