Web-based testing for cognitive epidemiology

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Background

Neurological and mental health problems are major contributors to the global burden of disability. Understanding the environmental and genetic factors underpinning these conditions requires epidemiological studies. Web-based cognitive testing has the potential to allow large-scale and high-frequency data collection in a cost and time effective manner. There is, however, legitimate concern regarding the validity of unsupervised testing, particularly in those with a history of mental health issues.

Objectives

- Identifying markers of inattention in online testing
- Comparing participants with and without a self-reported history of mental health issues (depression/ anxiety) on these metrics.

Methods

- 457 participants completed an on-line assessment of spatial working memory (SWM – Figure 1).
- Participants were asked to report whether they had a history of depression, anxiety or other neurological or psychiatric condition, and 200 participants completed the PHQ8 rating scale of depression symptoms.
- Complete data were available from 445 participants, of whom 148 completed the PHQ. Demographic characteristics are shown in table 1.
- SWM task yields measures of errors and strategy. We also extracted trial-by-trial data related to timing and browser information.
- Participants tabbing to a different browser window during testing was considered an "off-task" or inattentive behaviour.

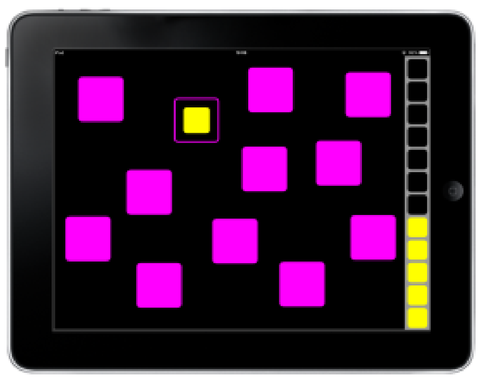

Figure 1
Working memory and executive function assessed using the CANTAB Spatial Working Memory (SWM) task, adapted for web-based testing.

Participants selected the boxes to search for a hidden yellow token. Once a token has been found, the box should not be touched again.

Participants are scored on errors and strategy use.

Results

Descriptive statistics

- Summary statistics are presented in table 1 for the entire sample and for subgroups defined by self-reported (SR) history of anxiety, depression and those with neither self-reported history nor positive score on PHQ.
- Participants SR depression tended to be younger but this was not significant (p=0.053).
- PHQ8 total score was significantly higher in those with SR history of anxiety (0.0211), and depression (p<0.001), and there was a high comorbidity between these two with 42 people reporting a history of both, and 45 reporting only one.

Predictors of inattentive behaviour

- We examined the predictors of several indicators of inattention: off-task browser behaviour, reaction time and variability in reaction time (SD and Coefficient of Variation (CV). Variables (e.g. education, gender) were not significant predictors in any model and are therefore not included here.
- Age is the only significant predictor of off-task behaviour, and reaction time variables. Younger participants were more likely to display off-task behaviour than older participants (Table 2).
- Self-reported history of depression or anxiety were not associated with any off-task behaviour or reaction time variables (Table 2).
- This finding was confirmed in a smaller sample who completed the PHQ8 (Table 3). There was no significant association between PHQ 8 scores and behavioural indications of inattention.

Impact of inattentive behaviour on task outcomes

- Off-task behaviour was associated with less accurate, faster responding. There was a significant main effect of off-task behaviour on performance on SWM accuracy (F=7.197; p=0.0077) and reaction time (F= 6.5; p = 0.011). The effect on strategy failed to reach significance (F=3.25; p= 0.0723).
- There was no main effect of SR diagnosis on any performance metric.
- For SWM Errors, there was a significant interaction between off-task behaviour and both depression and anxiety. Those without SR depression performed worse when they were off-task. There was no difference between the two conditions in participants with SR Depression and Anxiety (Figure 2).

Conclusions

- Participants with a self-reported history of mental health issues perform just as consistently as those with no such history in online testing, suggesting that this method of cognitive assessment can be used for screening into clinical trials or remote large-scale testing in such samples.

Table 1: Demographic and descriptive statistics

	n	Age	PHQ 8	SWM Errors	SWM Strategy	Mean Reaction Time (ms)	Reaction Time CV	off-task
all data	445	33.93 (4.04)	4.58 (5.19)	9.96 (9.17)	7.86 (3.47)	1117.39 (612.87)	57.05	44%
Anxiety (SR)	68	32.99 (4)	6.95 (6.49)	8.13 (8.62)	7.65 (3)	1073.48 (343.33)	52.98	43%
Depression (SR)	61	31.67 (4.06)	9.8 (5.95)	8.05 (7.82)	7.62 (3.23)	1049.54 (317.07)	57.17	37%
No self-report	359	34.46 (4.07)	2.57 (2.48)	10.3 (9.29)	7.98 (3.58)	1121.54 (658.76)	56.6	42%

Figure 2: impact of off-task behaviour on task performance

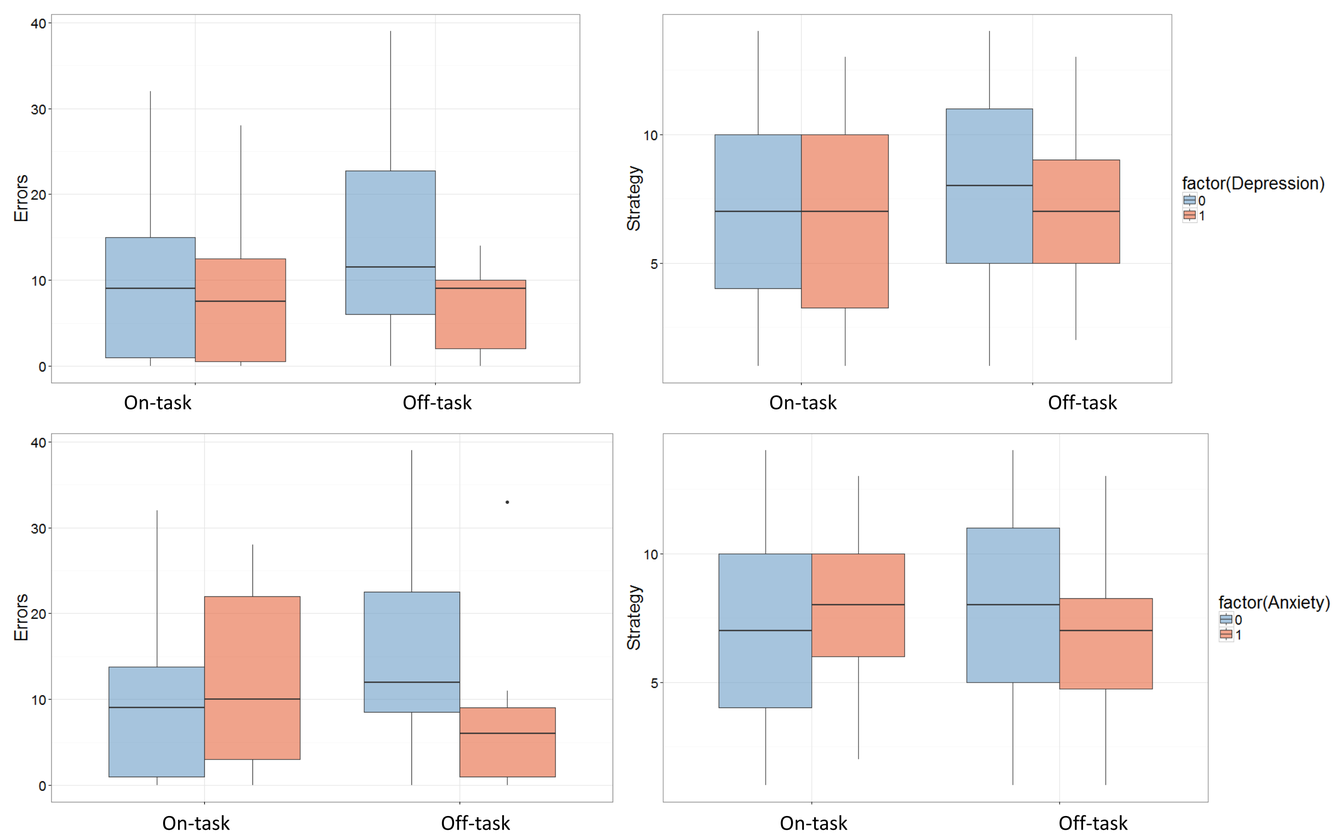

Table 2: Predictors of task adherence: self-rated depression and anxiety

Self-rated depression and anxiety and indices of on-task performance				
Model	OLS	OLS	OLS	logistic
Dependent Variable	Mean Reaction Time	Standard Deviation in RT	Coefficient of Variation	Browser visibility
Constant	765.74*** (555.67, 975.81)	1,337.22** (411.24, 2,263.20)	83.44*** (66.47, 100.41)	2.13*** (1.16, 3.11)
Age	10.70*** (4.87, 16.53)	-14.83 (-40.54, 10.88)	-0.78** (-1.25, -0.30)	-0.07*** (-0.10, -0.04)
Depression	-64.67 (-348.38, 219.03)	-69.11 (-1,319.68, 1,181.46)	6.41 (-16.51, 29.33)	-1.20 (-2.58, 0.17)
Anxiety	-36.25 (-280.98, 208.47)	-257.35 (-1,336.09, 821.40)	-4.06 (-23.84, 15.71)	0.08 (-1.13, 1.29)
Depression*Anxiety	50.05 (-362.91, 463.02)	39.93 (-1,780.41, 1,860.27)	-7.75 (-41.11, 25.62)	0.97 (-1.03, 2.97)
R^2	0.03	0.004	0.03	
Adjusted R^2	0.02	-0.01	0.02	
Log Likelihood				-180.10
Akaike Inf. Crit.				370.19
Residual Std. Error (df = 426)	613.65	2,704.93	49.58	
F Statistic (df = 4; 426)	3.47**	0.45	2.83*	
Note:				*p<0.05 **p<0.01 ***p<0.001

Table 3: PHQ 8 Depression scale as a predictor of task adherence

PHQ8 Score and indices of on-task performance				
Model	OLS	OLS	OLS	logistic
Dependent Variable	Mean Reaction Time	Standard Deviation in RT	Coefficient of Variation	Browser visibility
Constant	676.19*** (428.18, 924.20)	757.58*** (380.40, 1,134.75)	81.27*** (53.73, 108.80)	2.78*** (1.17, 4.40)
Age	11.23** (4.61, 17.84)	-5.33 (-15.39, 4.73)	-0.79* (-1.52, -0.05)	-0.10*** (-0.15, -0.05)
PHQ_total	5.89 (-6.40, 18.18)	11.93 (-6.76, 30.62)	0.51 (-0.85, 1.88)	0.04 (-0.03, 0.10)
R^2	0.07	0.02	0.04	
Adjusted R^2	0.06	0.01	0.03	
Log Likelihood				-87.51
Akaike Inf. Crit.				181.01
Residual Std. Error (df = 145)	386.28	587.47	42.89	
F Statistic (df = 2; 145)	5.57**	1.66	2.92	
Note:				*p<.05 **p<0.01 ***p<0.001

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