Feasibility and potential utility of a mobile eye tracking assessment of attentional bias to smoking cues: A pilot study

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Background

- In drug addiction, automatic attentional capture by drugs and drug cues is called **Attentional Bias (AB)**
 - Behavioral tasks such as the visual-probe task have been used to assess AB¹
 - AB has been shown to prospectively predict outcome in drug use cessation²
- **Eye tracking** has also been used in laboratory experiments to measure AB in drug users
 - Direction of initial fixation and overall dwell time are two commonly derived indices of AB in eye tracking studies³
 - Increased dwell time on drug stimuli compared to neutral is often the most sensitive eye tracking derived measure of AB⁴
- **Attentional Retraining (AR)** uses a modified version of the visual probe task (**Figure 2**) to retrain AB away from drug cues and toward neutral cues¹
 - AR is a novel potential treatment for addiction⁵
 - AR has typically been conducted in the lab

The objectives of this pilot study are to:

- 1) Determine feasibility of deploying AR on a PDA for an EMA study
- 2) Determine feasibility and potential utility of using a mobile eye tracking task to assess AB

Participants

- **Pilot (n=12)**
 - Community volunteers from Washington D.C. area
 - Active smokers (>10 cigarettes/day)
 - Age 18 – 65
 - Breath Carbon monoxide (CO) > 10ppm
 - Ethnicities
 - African-American: Pilot = 77%
 - Caucasian: Pilot = 11%
 - Other: Pilot = 11%
- Randomly assigned to AR group or no training control group
- Compensated per day in study and per completed RA

PILOT STUDY	Control (n = 3)	AR (n = 6)
<i>Participant Demographics</i>		
Sex	1 F 2M	3F 3M
Age	53.33 (5.13)	50.50 (4.59)
Years of Education	13.67 (2.08)	12.50 (1.38)
Cigarettes per day	11.67 (1.53)	15.83 (6.65)
FTND (0-10)	4.00 (1.73)	3.50 (1.52)
Age when started daily smoking	15.33 (0.58)	21.17 (11.23)
Lifetime Quit Attempts (+24hrs)	7.33 (2.89)	6.17 (3.49)

Table 1: Mean (SD) for Participant Demographics. FTND: Fagerstrom Test of Nicotine Dependence.

Materials

- The VP task was delivered on a PDA (HP iPAQ running MS PPC 2003 OS) see **Figure 1** for PDA and VP task description

Figure 1: Diagram of sequence of events in a single VP trial. 1) The fixation cross is presented for 500ms, 2) the two pictures – one smoking and one neutral – are displayed (500 ms), and 3) the probe to which the participant must respond is presented. For the **standard VP task** and **Control Task** the probe replaces neutral and smoking stimuli equally over all trials. For the **AR task** the probe replaces neutral stimuli on 100% of all trials. We computed AB index scores from the standard VP task as the difference in RTs on trials where the probe replaced the smoking picture vs. trials where the probe replaced the neutral picture. This formula yields an attentional bias index score with high (positive) values corresponding to an attentional bias toward smoking stimuli and a low (negative) values corresponding to an attentional bias away from smoking stimuli and toward neutral stimuli.

- Mobile Eye Tracking implemented with Applied Science Laboratory (ASL) Mobile Eye® mobile eye tracking system (**Figure 2**)
 - Spectacle mounted mini camera for scene and separate mini camera for pupil video capture.
 - Battery powered mini digital video recording device worn as hip pack

Figure 2: ASL Mobile Eye® mobile eye tracking system being worn by an individual. System includes two spectacle mounted mini cameras (one for scene and one for eye recording) connected via cable to battery powered mini digital video recorder in hip pack. The system is completely tetherless.

Figure 3: Screenshot of recorded video captured during mobile eye tracking assessment task. Smoking stimuli are on the right of the desk and red hash lines indicate gaze location.

Procedures

Figure 3: Timeline of Study

- **First lab session** (pre-training; see **Figure 3**)
 - Participants complete and sign informed consent
 - Participants complete questionnaire measures and biological samples are taken (saliva and breath CO)
 - Participants complete VP assessment of AB on PDA
- **7 days of EMA** (4 RAs per day; training sessions)
 - 3 AR/Control tasks per day
 - 1 VP assessment of AB task
- **Second lab session** (post-training)
 - Questionnaire measures and biological samples taken
 - Participants complete VP assessment of AB on PDA
 - Participants complete mobile eye tracking assessment of AB (**Figure 5**)

Figure 5: Screenshot of five video frames over 5.00 seconds duration of mobile eye task for one participant. Gaze tracking indicated by red circle and crosshairs. Area of Interest (AOI; smoking stimuli) highlighted in yellow. Elapsed time out of 5.00 seconds presented in lower left-hand corner of each frame along with fixation duration (in parentheses) in seconds. Each frame reflects one fixation in order of occurrence. This participant had five fixations. One fixation occurred before fixating on the smoking stimuli (fixation 1). Two fixations were on the smoking stimuli (fixations 2 and 4). And three fixations were not on smoking stimuli (fixations 1, 3, and 5). Time not accounted for within fixations were either saccades, loss of pupil data required for eye tracking, or brief fixations lasting less than .200 seconds. Some of this additional time was spent looking at the smoking stimuli.

SINGLE PARTICIPANT	Example Participant
<i>Mobile Eye Data</i>	
Total Number of Fixations	5.00
Fixations on Smoking Stimuli	2.00
Percentage of Fixations on Smoking Stimuli	40.00%
Total Fixation duration on Smoking Stimuli (seconds)	0.46
Number of fixations before first fixation on smoking stimuli	1.00
Duration before first fixation arrival (seconds)	1.76
Total time looking at smoking stimuli (seconds)	0.67
Percentage of time spent looking at smoking stimuli	13.40%

Table 2: Mobile eye tracking data from example participant.

Results

PILOT STUDY	Control (n=3)	AR (n=5)
<i>Mobile Eye Data</i>		
Total Number of Fixations	5.33 (0.58)	4.00 (2.12)
Fixations on Smoking Stimuli	2.00 (2.65)	1.20 (2.17)
Percentage of Fixations on Smoking Stimuli	34.44% (43.50)	19.29% (31.09)
Total Fixation duration on Smoking Stimuli (seconds)*	0.92 (0.97)	0.85 (0.87)
Number of fixations before first fixation on smoking stimuli*	2.00 (1.41)	1.50 (2.12)
Duration before first fixation on smoking stimuli (seconds)*	3.96 (0.49)	2.69 (2.95)
Total time looking at smoking stimuli (seconds)	0.90 (1.08)	0.40 (0.76)
Percentage of time spent looking at smoking stimuli	17.95% (21.54)	7.91% (15.14)

Table 3: Mean (SD) of selected mobile eye tracking data from pilot participants. Descriptive data. *Of those who had fixations on smoking stimuli (Control = 2, AR = 2)

Figure 6: Mean AB Index scores (1 SE) across all PDA assessments for 3 Control Participants (n = 18) and 6 AR Participants (n = 27) Descriptive data.

Attentional bias

- AR group demonstrated less AB (**Figure 6**) and less gaze dwell time (Total time looking at smoking stimuli and percentage of time looking at smoking stimuli; **Table 3**) than did the control group.

Discussion

- It is feasible to administer AR on a PDA in an EMA study
- It is feasible to use an ecologically valid mobile eye tracking measure to assess attentional bias in cigarette smokers
- Further research is needed to demonstrate the utility of this AB measure
- Future analyses will examine relationship between typical AB measures and mobile eye tracking AB measures with larger sample size.

References

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