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ORIGINAL PAPER

Blinking During and After Lying

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Abstract We tested the hypothesis derived from eye blink literature that when liars experience cognitive demand, their lies would be associated with a decrease in eye blinks, directly followed by an increase in eye blinks when the demand has ceased after the lie is told. A total of 13 liars and 13 truth tellers lied or told the truth in a target period; liars and truth tellers both told the truth in two baseline periods. Their eye blinks during the target and baseline periods and directly after the target period (target offset period) were recorded. The predicted pattern (compared to the baseline periods, a decrease in eye blinks during the target period and an increase in eye blinks during the target offset period) was found in liars and was strikingly different from the pattern obtained in truth tellers. They showed an increase in eye blinks during the target period compared to the baseline periods, whereas their pattern of eye blinks in the target offset period did not differ from baseline periods. The implications for lie detection are discussed.

Keywords Eye blinks · Deception

Introduction

Research has shown that eye blinks decrease when cognitive demand increases (Bageley and Manelis 1979; Bauer et al. 1987; Drew 1951; Goldstein et al. 1992; Holland and Tarlow 1972, 1975; Wallbott and Scherer 1991). For example, Holland and Tarlow (1972) found that participants blinked less when they had to memorize an 8 digit number compared to a 4 digit number over a period of 70 s. Research further suggests that during gaps of cognitive demand a flurry of blinks occurs (Holland and Tarlow 1972; Leal 2005; Malmstrom et al. 1977; Stern et al. 1984). For example, Holland and Tarlow (1972)

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instructed participants to add up numbers presented to them during trials containing 10 s intervals. For nine trials the number to add up on intervals 2, 4, and 6 was zero (which makes the summation task easy on these intervals). For the other nine trials, none of the numbers were zero. The trials that contained zeros resulted in more eye blinks than the trials that did not contain zeros, due to an increase in eye blinks during the intervals when the zeros were presented.

We thought that these findings could be relevant to predict eye blinks displayed during and directly after lying, and examined this in the present experiment. Lying is sometimes more cognitively demanding than truth telling (see below), and in such situations lying would result in a decrease in eye blinks. Once the lie is told, a break in cognitive demand occurs, which would result in an increase in blinking.

Cognitive Demand

Lying can be more cognitively demanding than truth telling (DePaulo et al. 2003; Zuckerman et al. 1981), and several aspects of lying contribute to this increased mental load (Vrij 2004, 2008; Vrij et al. 2006b, in press, 2008). First, formulating the lie itself may be cognitively taxing (Vrij 2008). Liars must need to make up their stories and must monitor their fabrication so that they are plausible and adhere to everything the observer knows or might find out. In addition, liars must remember their earlier statements, so that they appear consistent when re-telling their story, and know what they told to whom. Liars should also avoid making slips of the tongue, and should refrain from providing new leads. Second, liars are typically less likely than truth tellers to take their credibility for granted (DePaulo et al. 2003; Gilovich et al. 1998; Kassin 2005; Kassin and Gudjonsson 2004; Kassin and Norwick 2004; Vrij et al. 2006c). As such, liars will be more inclined than truth tellers to monitor and control their demeanor so that they will appear honest to the lie detector (DePaulo and Kirkendol 1989), which should be cognitively demanding. Third, because liars do not take credibility for granted, they may monitor the *interviewer's* reactions more carefully in order to assess whether they are getting away with their lie (Buller and Burgoon 1996; Schweitzer et al. 2002). Carefully monitoring the interviewer also imposes cognitive load. Fourth, liars may be preoccupied by the task of reminding themselves to act and role-play (DePaulo et al. 2003), which requires extra cognitive effort. Fifth, liars have to suppress the truth while they are lying and this is also cognitively demanding (Spence et al. 2001). Finally, whereas activating the truth often happens automatically, activating a lie is more intentional and deliberate, and thus requires mental effort (Gilbert 1991; Walczyk et al. 2003, 2005).

Obviously, lying is not always more cognitively demanding than truth telling (McCornack 1997). Perhaps the earlier stated reasons given as to *why* lying is more cognitively demanding could give us insight into *when* it is more cognitively demanding. That is, lying is more cognitively demanding to the degree that these six principles are in effect. For example, lying is likely to be more demanding than truth telling only when interviewees are motivated to be believed. Only under those circumstances can it be assumed that liars take their credibility less for granted than truth tellers and hence will be more inclined than truth tellers to monitor their own behavior and/or the interviewer's reactions. Second, for lying to be more cognitively demanding than truth telling, liars must be able to retrieve their truthful activity easily and have a clear memory of it. Only when liars' knowledge of the truth is easily and clearly accessed will it be difficult for them to suppress the truth. On the other side of the equation, truth tellers also need to have easy access to the truth for the task to be relatively undemanding. If truth tellers have to think hard to remember the target event (e.g., because it was not distinctive or it occurred long ago), their cognitive demands may exceed the cognitive demands that liars require for fabricating a story.

In experimental studies researchers ensure that interviewees are motivated (typically by giving a reward for making a credible impression) and that the target event is easily retrieved (typically by interviewing the suspects shortly after informing them about the target event), and the present experiment is no exception to this. When using this experimental setting, lying has been found to be more demanding than truth telling in various settings. Participants who have directly assessed their own cognitive load report that lying is more cognitively demanding than truth telling. This occurred not only when lengthy, elaborative responses, were required (Granhag and Strömwall 2002; Hartwig et al. 2006; Strömwall et al. 2006; Vrij et al. 2001, 2006c; Vrij and Mann 2006; White and Burgoon 2001), but also when short responses were sufficient (Caso et al. 2005; Vrij et al. 1996, 2006c). In fMRI deception research, lying and truth telling is differentiated only by the act of pressing either a “lie” or “truth” button. Nevertheless, participants’ brain activity reveals that lying is more cognitively demanding than truth telling (Spence et al. 2004).

In forensic settings, we can reasonably assume that interviewees will be motivated to be believed, but we cannot assume that interviewees will always be able to retrieve the target event easily, as this will vary from one case to another. Analyses of police interviews with real-life suspects, however, suggests that lying is often more cognitively demanding than truth telling in the forensic setting. First, in those police interviews, lies were accompanied by decreased blinking, increased pauses, and decreased hand and finger movements, all of which are signs of cognitive load (Mann et al. 2002; Vrij and Mann 2003). Second, police officers who saw videotapes of these suspect interviews reported that the suspects appeared to be thinking harder when they lied than when they told the truth (Mann and Vrij 2006).

Hypotheses

We expected the following patterns for eye blinks in liars and truth tellers. Liars, who make up an alibi about the target period, should experience more cognitive demand when recalling the target period deceptively than when recalling the baseline periods truthfully (see the Method section for details). We therefore predicted that liars would show less blinking when recalling the target period than when recalling the baseline periods. We further predicted that when this high cognitive demand ceases, i.e., directly after the lie is told, a flurry of blinks would occur (which we label the compensatory effect).

Truth tellers tell the truth during all periods, and should therefore experience equal cognitive demand during the target period and baseline periods. This would result in the same amount of blinking during the target and baseline periods. Since the target period is not associated with heightened cognitive demand in truth tellers, there is no theoretical reason why the compensatory effect would occur in truth tellers directly after the target period.

Method

Participants

In the experiment 26 participants (18 female, 8 male) ranging in age from 18 to 41 ($M = 22.38$, $SD = 6.89$) took part.

Procedure

Participants were approached with the question whether they were willing to participate in an experiment examining if deception could be detected by looking at changes in physiology. The experimental protocol involved two control (baseline) free recall periods and one experimental (target) free recall period. In the first baseline period, participants spent time with the experimenter in the psychophysiology lab and received information about the experiment. During this time, participants selected an envelope that they were to open when alone at the end of the session. They were informed that the envelope contained information as to whether they would be assigned to a 'liar' or 'truth-teller' condition and also instructions regarding what to do during this 'target' period of time. In the target period, 13 truth tellers were told to go about their normal business for 10 min but not to do anything that they may later have to lie about. The thirteen liars were asked to steal an exam paper from a professor's office. They were instructed to deny having stolen the paper later and to pretend to have done something else instead. All participants completed the study as requested. After the 10 target minutes, liars and truth tellers returned to the psychophysiology lab. They then received information about the physical measures that would be taken (second baseline period). The experimenter, unaware of the veracity condition to which the participants were allocated, asked each participant to freely recall exactly what they were doing, including as much detail as possible during the 1st, 2nd, or 3rd 10 min time period. After the interviewee finished their recall about one period, the experimenter waited ten seconds before asking the question about the next period. The order in which the two baseline periods and target period were recalled was counterbalanced. The response length of baseline period 1 ($M = 59.2$, $SD = 21.9$), baseline period 2 ($M = 68.60$, $SD = 21.6$), and target period ($M = 67.61$, $SD = 26.5$) did not differ significantly for truth tellers and liars (all $F(1,24)$s $< 0,55$, all p's > 0.46).

To motivate participants they were informed that if they gave a detailed and convincing account of what they were doing during each period then they would be entered into a draw to win a £100 bookstore voucher. (In reality all participants were entered into the draw.) The participants were also told that they would take part in a polygraph test to examine the veracity of their statements. (We submitted them to a guilty knowledge polygraph test, not discussed in this article.) Previous research revealed that polygraph tests appeal to participants and motivate them to perform well (Vrij et al. 1997). The experiment was conducted in accordance with BPS guidelines. After the experiment had finished, all participants received a full debriefing and were assured that the 'stolen' exam paper was not in fact a real copy but rather one devised by the experimenter who had no knowledge as to which questions would subsequently be asked in their real exam.

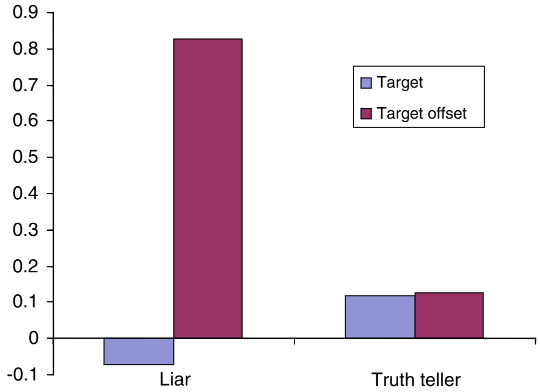
Blink rates were recorded using a Neuroscan 4 amplification and software package. Two electrodes above and below the left eye monitored blinks, while electrodes placed at the side of both eyes monitored horizontal eye movements. Impedances were kept below 5 KΩ and signals were filtered with a bandpass of 0.15–50 Hz. The gain was set at 250 for each of the electrodes. Blink data were digitized at a sampling frequency of 250 Hz and stored on disc for later analysis. Recordings of blinks began 10 s pre-stimulus, and continued throughout the experimental session. The scores of the two baseline periods were combined for the data analyses. Changes in blinking during the target period and baseline periods were calculated for each participant by subtracting their baseline values from the target period responses. To measure the compensatory effect, we calculated for each participant the eye blinks displayed during the 6 s immediately after the target period, and subtracted the baseline values from this offset value.

Results

No differences in blink rate emerged between truth tellers and liars in the baseline period, $F(1, 24) = 1.26$, *ns*, $\eta^2 = .05$ or target period, $F(1, 24) = .86$, *ns*, $\eta^2 = .04$, whereas in the target offset period truth tellers ($M = .65$, $SD = .44$) displayed fewer eyeblinks than liars ($M = 1.53$, $SD = 1.1$), $F(1, 24) = 7.07$, $p < .05$, $\eta^2 = .23$. However, it is common practice in psychophysiological research to use "change" or "percentage" scores in preference to raw values ($M = +.02$, $SD = .17$). These methods are used to avoid individual differences in participants' initial physiological values distorting the means.

Changes in eye blinks from baseline that occurred during and immediately following the target period are illustrated in Fig. 1. A mixed 2 (Veracity: truth vs. lie) × 2 (Phase: during target and target offset) ANOVA was conducted. No main effect for Veracity was found, $F(1, 24) = 2.30$, *ns*, $\eta^2 = .09$, but there was a main effect for Phase, $F(1, 24) = 7.05$, $p < .01$, $\eta^2 = .23$, whereby overall there were fewer blinks per second during the target period ($M = +.02$, $SD = .17$) than in the target offset period ($M = +.48$, $SD = .93$). There was also a Veracity × Phase interaction effect, $F(1, 24) = 6.76$, $p < .05$, $\eta^2 = .22$. Follow up *t*-tests on liars and truth tellers separately revealed that, as reported in Fig. 1, liars displayed a reduction in blink rate during the target period compared to baseline ($M = -.07$, $SD = .11$), ($t(12) = 2.29$, $p < .05$, $d = .64$), and that, conforming with the compensatory effect hypothesis, this was followed by an increase in blink rate in the target offset period compared to baseline ($M = +.84$, $SD = 1.16$), ($t(12) = 2.56$, $p < .05$, $d = .72$). In contrast, truth tellers' blink rate increased during the target period compared to baseline ($M = +.12$, $SD = .16$), ($t(12) = 2.58$, $p < .05$, $d = .75$), whereas no significant difference occurred in blinks in the target offset period comparison to baseline ($M = 13$, $SD = .42$), $t(12) = 1.09$, *ns*. When we compared the blinks during the target period with the target offset period, we found a significant difference for liars (they displayed an increase in blinks during the target offset period compared to the target period), $F(1, 12) = 8.06$, $p < .05$, $\eta^2 = .40$, but not for truth tellers, $F(1, 12) = .001$, *ns*, $\eta^2 = .00$. In total, 10 out of 13 liars (77%) demonstrated the pattern associated with deception (e.g., inhibition of blinking during the target period and the increase in blinking during the offset period) whereas only two out of truth tellers (15%) showed this pattern.

Fig. 1 Changes in blink rate per second during the target period and directly after the target period (target offset)



Discussion

This experiment demonstrated that in situations when lying requires cognitive demand, lying is associated with a decrease in eye blinks followed by a compensatory effect: An increase in eye blinks directly after the lie is told and cognitive demand has ceased. It is striking what different patterns in eye blinks emerged for liars and truth tellers (see Fig. 1); such striking differences in behavior between liars and truth tellers are rarely seen in deception research (DePaulo et al. 2003; Vrij 2008). Liars displayed a decrease in blinks during deception (i.e., the target period) compared to baseline and this was followed by an increase in blinks in the offset period when the lie was told (compared to both target period and baseline). Truth tellers showed an increase in eye blinks during the target period compared to baseline which was not followed by a change in blinks directly after the target period (compared to both target period and baseline). The increase in eye blinks in truth tellers was not predicted but could perhaps be explained in terms of anxiety. Perhaps truth tellers experienced more anxiety during the target period than during baseline, as they may have realized that the target period is the key component of the test where their credibility would be assessed. Anxiety is associated with an increase in eye blinks (Chiba 1985; Harrigan and O'Connell 1996; Tecce 1992). Since the target period is not associated with heightened cognitive demand in truth tellers, there is no theoretical reason why the compensatory effect would occur in truth tellers, and, indeed, it did not occur.

Whether lie detectors unknown to our findings will interpret the eye blinks displayed by liars and truth tellers correctly remains to be seen. Research has demonstrated that lie detectors typically associate an increase in eye blinks with deception (Strömwall et al. 2004; Taylor and Hick 2007; Vrij et al. 2006a). Our findings suggest that they would (i) incorrectly classify truth tellers as liars and (ii) incorrectly classify liars as truth tellers when they rely upon eye blinks to detecting deception in circumstances where lying requires cognitive load.

Skeptics may argue that we used a low-stakes situation and that our findings that liars reduced their blinking when they experience cognitive load may not hold true when the stakes are high. Perhaps in high-stakes situations, where the outcomes really matter to liars, the anxiety that liars experience gets the overhand and that they will show increased eye blinks when lying. Mann et al.'s (2002) research, in which the eye blinks displayed by suspects in police interviews when they told the truth and lied during these interviews were examined, suggest that the skeptics may be wrong. Mann et al.'s study was clearly a high-stakes study as the suspects were suspected of serious crimes such as murder, rape, and arson. Yet the suspects showed a decrease in eye blinks when lying. Whether this was followed by a compensatory effect immediately after the lie was told is unknown, as this has not been analyzed. It cannot be analyzed either because of the ground truth. Although Mann et al. have established the ground truth *during* the truths and lies, the ground truth of the statements *directly after* the truths and lies is unknown in their dataset.

As a practical implication of our findings, we believe that patterns of blink rate could be monitored to help professional lie-catchers identify parts of suspects' statements that are indicative of deception and thus warrant further scrutiny. A benefit of monitoring blink rate rather than other physiological measures is that it can be done non-intrusively via a remote camera that could pick up eye blinks by monitoring occlusion of the retina (Stern 2006, personal communication to Sharon Leal) which makes it applicable in many situations.

Our observations for liars may not just be related to eye blinks. For example, when Clinton testified before the Grand Jury in the Monica Lewinsky case, he sat very still when he answered potentially incriminating questions about whether or not he ordered his personal secretary to go to Lewinsky's home to collect the presents she had received from him (Vrij 2002). However, he made several subtle shifting movements after answering these questions. We hope that our article will stimulate further research into the behaviors displayed by liars during and directly after the lie in situations where they experience cognitive load.

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