THE COGNITIVE EFFORT OF LYING

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Abstract

Being able to directly measure if an individual is lying or not can have many advantages. The current study set out to determine if there were differences in cognitive effort when lying and telling the truth. Participants (N=20) were asked to create or recall 8 events from the Life Events Inventory list. In half of the trials participants told a story, in the other half they told a story and performed an irrelevant simple reaction time task. Disfluency in the participant's narratives and reaction time in the reaction time task were measured to assess how well participants performed each task. For the reaction time task, there were significant differences between the task type conditions, but not between the story type conditions. For the disfluency measures, there were significant main effects of story type (truth versus lie) for all measures, but no main effects of task type (dual versus single). There was an interaction for filled pauses which indicated more filled pauses for the single, lie condition than any other condition. Overall, reaction times suggested no difference in cognitive effort when lying or telling the truth, whereas disfluency suggested there were some cognitive differences.

Cognitive Effort of Lying

Lying involves a series of complex cognitive actions that are assumed to require an extensive amount of effort (Meek, Phillips, Boswell, & Vendemia, 2013). The liar has to retrieve information from long term memory, come up with a believable response, evaluate the response, and think about consequences of that response to make sure it is believable (Meek et al., 2013). While it takes a lot of effort for people to lie, everyone varies with respect to their detectablity as liars (Bond & DePaulo, 2008). This is important because successful lie detection aids our law enforcement when trying to distinguish a guilty individual from an innocent one.

One of the most commonly used methods of lie detection is arousal based detection. Arousal based detection is based on the idea that liars will have higher anxiety and nervousness levels than truth tellers because of the fear of getting caught (Vrij, Fisher, Mann, & Leal, 2006). By this logic, liars should display physiological cues to anxiety or nonverbal cues related to nervousness (Vrij, 2014). These cues include increased heart rate, heightened blood pressure, increased galvanic skin response, gaze aversion, shifting position, or an increase in movements (Vrij, 2014). One reason this approach should not be used on its own is because there are too many individual differences in emotionality. It is hard to determine why the individual is showing signs of arousal, and therefore this approach leaves much room for error (Lykken, 1979).

A different, newer method of lie detection that has started to gain some attention is cognitive based detection. Cognitive based detection suggests that it is more cognitively demanding to tell a lie than it is to tell the truth and that this increased cognitive load increases the cognitive resources one must use in order to lie effectively (Vrij et al., 2006). This should

make it easier to spot liars because they should perform worse on secondary cognitive tasks (Vrij et al., 2006). It is expected that liars should falter more when asked unexpected questions, struggle to maintain and monitor their demeanor, and have a harder time keeping their fabricated story in order because these tasks are cognitively demanding (Vrij, 2014). They also have to infer how others are interpreting their story to avoid making the impression that they are lying (Vrij et al., 2006). Since these tasks are adding extra cognitive effort to an already effortful task, cognitive resources should be depleted much faster than when a person is telling the truth. This situation should cause the individual to struggle more than someone who is telling the truth (Vrij, 2014). When tasks become harder, performance is expected to decrease because of limited resources (Franconeri, Alvarez, & Cavanagh, 2013). Liars must perform multiple tasks at once, which severely depletes their cognitive resources. Therefore, with increased cognitive load it is expected that liars will not be able to cope with additional tasks as well as someone who is telling the truth (Vrij & Granhag, 2012). With the increased struggle to lie convincingly, the liar should show more signs of deceit and therefore can be identified more easily. Liars have to suppress nervousness, mask evidence of thinking too hard, and be aware of how they normally respond in order to seem genuine (Vrij, 2004). These actions can lead to behavior that seems planned, is less fidgety, involves fewer hand or arm gestures, and can include talking in a higher pitched voice (Vrij, 2004; Vrij, 2006).

The cues that arousal based detection focuses on are physiological indicators of being anxious or nervous. This is not a sufficient method to decide if an individual is lying or not because psychological states can be influenced by many factors. For example, people can have heightened physiological states due to emotion (Lykken, 1979). If a question is asked during an interview that evokes an emotional response, it could be because the individual is being

deceptive, he or she is being truthful but is ashamed to admit it, or because the question can touch on an embarrassing or painful memory or issue (Lykken, 1979). There is no exact way of knowing the reason for the emotion which elicits the physiological response (Lykken, 1979).

Supporting this point, a review by the US National Research Council showed that liars do not necessarily show more arousal with key investigation questions than truth tellers, and truth tellers can feel just as anxious during an interview which would heighten their arousal and nervousness levels (National Research Council, 2003). In this review, 50 separate laboratory studies were analyzed which included 3,099 polygraph examinations. The studies collected were put into three separate categories: deception indicated, no deception indicated, or inconclusive. There was substantial variability in the number of guilty examinees who were correctly identified as lying. When all of the studies were compiled and a cutoff was used that had a false positive rate of approximately 10 percent, the data showed that accuracy varied from 43 to 100 percent (National Research Council, 2003). This means there was high variability across the studies when it came to people's ability to detect deception. One phenomenon that can account for this large range is strong emotional responses to questions being asked. The fear of being falsely accused, which would heighten the emotional response to key investigation questions, can mimic the arousal that is shown by deceivers (National Research Council, 2003). That makes arousal based detection a more subjective measure that is greatly dependent on the interviewer's interpretation of the interviewee's behavior.

Conversely, the claim is that cognitive based detection uses more direct cues to determine whether an individual is lying or telling the truth. Lying takes planning, strategizing, paying attention, and remembering detail in order to be successful (Vieira & Lane, 2013). In a study by Mann, Vrij, and Bull (2002), police officers were asked to compile videos of suspect interviews

in which the suspects had previously lied or told the truth. These videotapes were coded for behaviors such as pauses, hand movements, and blinking. It was found that liars tended to blink less and pause more during the interviews, suggesting that there were possibly more cognitive resources were being used (Mann et al., 2002). Participants in mock-suspect experiments have also assessed their own cognitive load when lying versus telling the truth and reported lying was more cognitively taxing than telling the truth during interviews (Vrij et al., 2006).

It is essential to have more objective measures when distinguishing between liars and truth tellers. While these studies point to the conclusion that lying is more cognitively demanding than telling the truth, if detection strategies are going to be based on this idea, then objective measures must be used in order to see if this difference actually exists. Therefore, the relative difficulty of these tasks should be assessed by behavior that has already been established as evidence of cognitive effort. In order to achieve this, there has to be a link between tasks of higher cognitive effort and behavior. Tyler, Hertel, McCallum, and Ellis (1979) found that the amount of cognitive effort involved in a task influences reaction times in a secondary task. Cognitive effort was manipulated by using two tasks, anagrams and sentences. For the low effort anagram condition, the change in position of the letters was minimal (e.g., dortoc for doctor) and for the high effort anagram condition the change in position of the letters was greater (e.g., croodt for doctor). In the sentence task, participants had to fill in the final word in the sentence. In the low effort condition, the missing word was strongly predicted by the other information in the sentence, while the high effort condition provided less information in the sentence. The experimenters assessed the difficulty of the cognitive tasks by having participants perform a secondary simple response task in which participants pressed a button when they heard a tone. This was designed to indicate the difficulty of the primary tasks based on the assumption that

there are limited cognitive resources that can be allotted to different aspects of task solving (Bruken et al., 2003). According to this assumption, cognitive resources are allotted to the primary task first, and as a result there are fewer resources left over for the secondary task (Schoor, Bannet, & Bruken, 2012). If the primary task takes up more cognitive resources, meaning it has a higher load, then it would be assumed the reaction time to the secondary task would reflect that inversely (Schoor et al., 2012). Thus, the more difficult a primary task is, the longer reaction times will be for the secondary task (Schoor et al., 2012). Tyler et al. (1979) found the high effort anagram and sentence conditions had longer reaction times than the low effort anagram and sentence conditions. The harder the primary task was to perform for the participants, the longer the reaction time became in the secondary task (Tyler et al., 1979). These measures of difficulty can provide more insight into whether someone is really lying because it will make people stumble more when given secondary tasks due to the increased cognitive effort.

In the current study, cognitive load was assessed to determine whether lying or telling the truth requires more effort. A dual-task paradigm was used to assess the effort involved. The dual-task paradigm consisted of a primary task and a secondary task that were performed simultaneously (Bruken, Plass, & Leutner, 2003). If it can be established that it is in fact more effortful to tell a lie than to tell the truth it can have important implications for distinguishing liars from truth-tellers. It was predicted that lying would take more cognitive effort than telling the truth. Participants in this study told eight narratives (four truthful, four fabricated) while simultaneously performing a secondary visual reaction task. It was expected that reaction times would be longer when the participant was telling a fabricated story than when they were telling a truthful story due to the assumption that it is more cognitively effortful to lie than to tell the truth. Disfluency in speech was also assessed. Disfluency in speech included false starts, unfilled

pauses, and filled pauses with words like ‘um,’ ‘hmm,’ and ‘uh’ (Brennan & Williams, 1995; Duez, 1982). Anolli and Ciceri (1997) found that when an individual performs a complex task they have more interruptions in their speech compared to when they are performing a simple task. These interruptions indicate that a person has to continuously make decisions in order to finish their thought. These researchers also found that when people have planned out lies there are fewer disfluencies than when a person is not prepared for the lie. They also found that there were more disfluenices when an individual was lying compared to when they were telling the truth, regardless of if the lie was planned or not. More pauses were heard when the task was more difficult, demanding, and unfamiliar (Anolli & Ciceri, 1997). Since this type of disfluent speech is typical of more demanding tasks, it was expected that participants in the lying conditions would have more filled and unfilled pauses than those in the truthful conditions.

Method

Participants

There were 20 participants recruited from the SUNY New Paltz subject pool. All participants reported being native English speakers without any speech impediments and reported having normal or corrected to normal vision. Two participants were excluded from the data analysis due to not completing the experiment.

Materials

The Life Events Inventory (LEI) (Polage, 2004; Garry et al., 1996) (see appendix B) was used to provide participants with a list of various life events that may or may not have happened to them in order to create fabricated stories or to recall true ones. The experimenter added two events to the LEI in order to ensure the recall of true life events. These events included, “Have

you ever had a birthday party?" and "What was your first day of college like?" Along with the LEI, participants received a set of written instructions outlining the procedure they were to follow (see appendix C).

Design

This study consists of two different comparisons. The first was a three-group comparison in which reaction times to the visual reaction task were assessed. The lie condition, truth condition, and visual task condition were compared to assess the differences in reaction times. The second was a 2x2 within subjects factorial design in which speech disfluencies were assessed. Disfluency was measured in three ways: filled pauses, unfilled pauses, and false starts. The design included a single task lie condition, a dual task lie condition, a single task truth condition, and a dual task truth condition. In the single task lie condition as well as the single task truth condition disfluency in the narratives by the participants was recorded. In the dual task conditions, participants' performance on a secondary visual task as well as the disfluency in speech in the narratives was recorded.

Procedure

Participants came in and were seated in front of a computer. They were given a piece of paper that included the Life Events Inventory (LEI) (see appendix B) and directions (see appendix C). They were told that they would be creating one story at a time based on different events on the LEI. Every story was audio recorded. The participants told four fabricated stories and four truthful stories in all. The order of the trials was randomized for each participant.

For the story task, participants were asked to do one of two things: either pick a situation that they actually experienced and recall the events in detail or pick a situation they had not

experienced and create a story surrounding that event. The experimenter informed the participant which task they would do at the beginning of the trial. If the task involved a fabrication, participants were told to be as convincing as possible. Once the participant was instructed on what to do the experimenter left the room. Participants were being audio-recorded the entire time they were seated in front of the computer. They were given a maximum of three minutes to recall or create the stories. Once the participant felt ready, or the three minutes were up, he/she pressed the spacebar on the computer to start the time for the participant to tell their story. Each story lasted for one and a half minutes with the computer alerting the participant when the time was up. Once the time was up, the participant notified the experimenter who came back into the room to instruct them on what to do next. This was repeated eight separate times until four truthful narratives were told and four fabricated narratives were told.

For the reaction time task conditions, participants were instructed to respond to a visual stimulus presented on the computer screen. Participants saw a cross appear on the screen and were instructed to hit the spacebar every time it appeared. The inter-stimulus interval was randomly varied between 3 and 5 seconds. The cross appeared 18 times per condition. The cross stayed visible on the screen until the spacebar was pressed. Reaction times to the stimulus were recorded. There were two dual task conditions wherein the participant told the narrative as well as performed the secondary reaction task and two single reaction task trials wherein the participants only performed the reaction task.

Results

Data Reduction

Reaction times for the secondary visual task were recorded using E-Prime. There were 36 raw reaction time scores for each condition per participant. Each participant had a total of 108 raw data scores which were then averaged for each condition yielding 3 separate scores per participant (dual lie score, dual truth score, and single reaction task score).

Disfluency in speech was measured using three different indicators: filled pauses, unfilled pauses, and false starts. Filled pauses included the use of the words ‘um’, ‘uh’, ‘so’, ‘like’, and ‘and’ (Brennan & Williams, 1995). Unfilled pauses included any silence longer than 200 ms (Duez, 1982). False starts included the participant starting a sentence, then restarting the sentence in a different way or using different words (Duez, 1982). The number of filled pauses, unfilled pauses, and false starts were counted in each narrative, then the raw scores for each condition were averaged and analyzed. Scoring was done by the researcher who was blind to the condition that was being coded. A naïve coder was used to check a portion of the narratives. There were no significant differences in the coding of the two researchers ($p=.271$). They agreed on 70% of trials.

Analyses

Reaction Time

A one-way three-group repeated measures ANOVA was run to examine the differences between reaction times in the separate conditions. The lie condition, truth condition, and visual task condition were compared (Figure 1). There was a significant main effect of condition,

$F(1.177, 20.014) = 10.67$, $p = .003$. Pairwise comparisons revealed a significant difference between the visual task condition ($M = 362.31$, $SD = 96.75$) and the lie conditions ($M = 722.52$, $SD = 392.07$), $t(17) = 3.953$, p = .001, as well as the truth condition ($M = 608.71$, $SD = 186.29$), $t(17) = 7.427$, p < .001. There was no significant difference between the lie condition and the truth condition ($p = .263$).

Disfluency

Three 2 story (true narrative, lie narrative) x 2 task (single task, and dual task), repeated measures factorial ANOVAs were run to examine each of the three disfluency measures. For filled pauses, there was a significant main effect of story, $F(1,17) = 19.30$, $p < .001$. This means there were significantly more filled pauses for the lie conditions ($M = 13.33$, $SD = 4.88$) than there were for the truth conditions ($M = 10.17$, $SD = 3.82$). There was no main effect of task for filled pauses ($F(1,17) = 2.46$, $p = .136$), implying there was no difference in the number of filled pauses in the single task condition ($M = 12.42$, $SD = 4.64$) and in the dual task conditions ($M = 11.08$, $SD = 4.33$). There was a significant interaction (Figure 3) between the type of story and the type of task, $F(1,17) = 13.07$, $p = .002$. Post hoc analyses revealed a significant difference between filled pauses during the lying task and the truth task only for the single task condition ($t(17) = 6.06$, $p < .001$). There were no significant differences between the story types for the dual task condition ($p = .427$).

For unfilled pauses, there was a significant main effect of story type, $F(1,17) = 25.87$, $p < .001$. There were significantly more unfilled pauses for the lie conditions ($M = 5.08$, $SD = 2.95$) than there were for the truth conditions ($M = 2.17$, $SD = 2.12$). There was no significant main effect for task type $F(1,17) = .054$, $p = .820$, indicating there were no differences in the number

of unfilled pauses in the single and dual task conditions. There was no significant interaction between story type and task type, $p = .878$ (Figure 4).

For false starts, there was a significant main effect of story type, $F(1,17) = 14.41$, $p = .001$. There were significantly more false starts in the lie conditions ($M = .69$, $SD = .52$) than there were in the truth conditions ($M = .22$, $SD = .43$). There was no significant main effect of task type, $F(1,17) = .922$, $p = .350$, suggesting no differences in the number of false starts in the single and dual task conditions. There was no significant interaction between story type and task type, $p = .598$ (Figure 5). Overall, the results of the three disfluency measures indicate that there were significant differences in the level of cognitive effort the participants exerted to complete the tasks.

Discussion

In the current study, participants performed significantly worse in the visual reaction task when they were given a dual task as opposed to a single task, regardless of the story condition (Figure 2). These results suggest that it is more difficult to perform the visual reaction task while telling a narrative than it is to just perform a visual reaction task, which was expected. There were no significant differences in reaction times for the reaction task when people were telling the truth as opposed to lying. This suggests that there were no differences in how cognitive effort impacted performance for the lie condition and the truth condition.

While there were no significant differences between these conditions for the reaction time task, there were significant differences between story types for the disfluency measures. The three measures that were used to assess disfluency in speech were filled pauses, unfilled pauses, and false starts. There were significantly more filled pauses in the lie conditions than there were

in the truth conditions, but no significant differences between the task conditions. It was expected that participants would use more filled pauses in the lie conditions, but unexpected that there would be no significant differences between task conditions. This indicates that participants used more words like ‘um’, ‘like’, and ‘uh’ in their narratives when they were lying as opposed to telling the truth, regardless of the task condition (dual versus single). There was an interaction between story type and task type suggesting that task type had an influence on the number of filled pauses in the truthful condition and lie condition. There were significant differences between the number of filled pauses for the lie and truth conditions in the single task condition, but not in the dual task condition, which was unexpected. The lie, single task condition had more filled pauses than any other condition, when it was predicted that the lie, dual condition would have the most filled pauses. There were significantly more unfilled pauses and false starts when the participants were lying than when they were telling the truth, but no significant differences between if a single or dual task was being performed. It was expected that participants would have more disfluencies in the lie conditions, due to lying being a complex task (Meek et al., 2014), as well as more disfluencies in the dual task conditions, because they must perform two tasks at once.

Overall, there were more disfluencies for the lie conditions than the truth conditions. Past research has shown that there are more disfluencies in speech the more demanding a task is (Anolli & Ciceri, 1997), suggesting that the disfluencies found in the lie conditions may indicate that it was harder. Previous research has also found that when people lie there are more repeated words and interruptions in speech than when they tell the truth (Anolli & Ciceri, 1997). This can cause the speech to seem less eloquent to a listener, which invokes the suspicions that someone is lying (Anolli & Ciceri, 1997). Liars also had less eloquent speech and had a harder time

emphasizing or softening their words than truth tellers when they were interviewed (Anolli & Ciceri, 1997), suggesting that they had a harder time answering the questions that were being asked. Their finding supports the assumption that lying is a more difficult task than telling the truth. While the reaction times of the visual task suggest that there were no differences in cognitive effort when the participant was lying or telling the truth, the disfluencies in speech suggest otherwise. Since there were significantly more disfluencies in speech for the lie conditions than truth conditions, lying was harder for the participant.

One possible reason why there were no differences in reaction times for the lie and truth conditions but a significant difference in disfluencies for the lie and truth condition is the cognitive resources that went into each task. If people are limited in cognitive resources, then they must split them up if they are given more than one task at a time. For the dual task conditions, participants had to dedicate some of those resources to the reaction time task as well as some to telling their narrative. Participants could have given the reaction task the same amount of resources for the lie condition as they did for the truth condition, making the reaction times for those two conditions similar. Participants could have shifted their primary focus from the narratives to the reaction task, giving the same amount of resources to the reaction task whenever they had to complete it. This could help explain why there were no differences in reaction times for the lie and truth conditions. Once the participants used up whatever amount of resources they needed for the reaction task, they had to dedicate what was left to the narrative conditions. If lying takes more cognitive resources to be successful than telling the truth does, then participants may have had enough resources left over to tell the truth but not to lie. The current study found significant differences in disfluencies for the lie and truth condition, which could support the idea that participants did not have enough resources to lie but had enough to

tell the truth. This was evident through more disfluencies in the lie conditions, suggesting that lying was the harder task.

The current study also found that there were no differences in disfluencies for the task type except for an interaction for filled pauses. The single task condition had significantly more filled pauses in the lie condition than the truth condition whereas the dual task condition showed no difference. This was unexpected because it has been found that people perform worse when they are given more than one task at a time (Miller & Durst, 2014). Performing one task should take up fewer resources than performing two tasks, so the dual conditions should have been more difficult for the participants. This would have been evident through the disfluencies if there were significantly more of them in the dual conditions, but that did not happen. Previously, it was found that the dual conditions took more effort than the single conditions, which was shown by the reaction times for the two tasks, but fewer disfluencies were found in the dual task conditions than the single task conditions. Considering the previous finding, that the dual conditions took more cognitive effort to complete than the single conditions, it was expected that the dual conditions would have significantly more filled pauses than the single task conditions, regardless of the type of narrative being told. Overall, these results were not what was expected and require future examination in order to appropriately observe what caused the unanticipated outcomes.

One variable that could have influenced the finding that there were no significant differences in the dual versus single conditions is incentive. In the current study, the incentive to lie was relatively low. There were no real consequences if the individual was caught lying or did not lie to the best of their ability. A common occurrence in doing a lab study as opposed to a field study is that participants are in low-stake situations with little incentive to lie convincingly. Researchers can offer rewards to try to get the participant to be convincing, but they cannot

ethically have a punishment as motivation to lie, therefore participants may not exhibit the same behaviors as people who are in real life situations (Mann et al., 2002). If the incentive to lie is low, then two things could have happened: participants could have not cared about the task and therefore would not have performed it to the best of their ability or, regardless of the low incentive, participants could have tried to perform the task to the best of their ability. If the former, it should have been possible to distinguish between when the participants were lying and when they were telling the truth. For most participants this was not the case. When listening to most of the participants' stories, it was difficult for the researcher and the naïve coder to distinguish when they were lying and when they were telling the truth. Due to this, it can be assumed that participants still tried to lie to the best of their ability. While participants were informed to lie as convincingly as possible, they were not informed or given specific instructions on how to tell their lie. With the combination of having a low incentive to lie and not being given specific instructions on how to lie, there could have been many different approaches to the task. For example, participants could have told a completely made-up lie where nothing in the story was true, they could have told a half made-up story where they pulled from true events but changed a few things, or they could have not been lying at all. There was no way to tell which of these strategies participants used. They could have been trying to strategize a way to make the task less effortful, which would create no differences in disfluencies for the tasks. If participants only told a half made-up story or just told the truth the entire time then the level of cognitive effort exerted may not have been as high as it would have been if they created a completely fabricated lie from the start. Since there was no strong incentive to completely make up a story, this could have made the task of lying cognitively easier because there was no incentive to perform the task the way it was intended.

While participants could have been strategizing on how to make telling their stories the least cognitively demanding, they also could have just been planning well. Participants knew which task they were going to be completing before they were given their three minutes to plan. It is possible that participants just used their three minutes more wisely when they knew they had to perform two tasks at one time. If there was a lot of preparation that went into the lie, it is possible that there would be fewer differences in speech. While it has been previously found that when people lie there are more disfluencies than when they tell the truth (Anolli & Ciceri, 1997), having a lie previously planned out can change patterns of speech. Prepared lies normally have fewer signs of deceit than spontaneous lies do (Vrij & Granhag, 2012). Therefore, if the liar anticipates what is going to be asked of him or her or is able to take time to plan a story they must tell, then the number of disfluencies may go down. In the current study, participants were given time to prepare their lies. While there were more disfluencies in the lie condition overall, an interaction for filled pauses showed when the lie condition was moderated by the task type, there were more disfluencies in the single task conditions than the dual task conditions. This could be explained by the amount of planning that the participants did for each condition. The participants could have planned their lies for the dual conditions in more depth because they knew they had to perform more than one task already, whereas for the single task they were aware they could focus solely on the story. This could have influenced the number of disfluencies in both task conditions. Overall, the finding that there are significantly more disfluencies when an individual is lying supports previous research and could be used, along with other techniques, to help determine if someone is lying or telling the truth.

The finding that it is more demanding to perform a dual task as opposed to a single task has been supported by many other studies (Miller & Durst, 2014; Schoor et al., 2012; Tyler et al.,

1979). Previous research has found that there have been more disfluencies in speech when the level of cognitive effort was high compared to when it was low (Anolli & Ciceri, 1997), therefore, it would be expected that the condition that has the higher number of disfluencies would be a more cognitively demanding task. Importantly, even though the reaction times in the current study showed no difference between the cognitive effort of lying and telling the truth, the disfluencies in speech demonstrated differences. The lie condition has higher numbers of disfluencies for filled pauses, unfilled pauses, and false starts, suggesting that it was more cognitively demanding to lie than it was to tell the truth. Overall, this study found that it is more cognitively demanding to perform a dual task than a single task. It also found more disfluencies in speech when an individual was lying as opposed to telling the truth.

While the present research sheds light on the cognitive effort that lying and truth telling require, there remains much more to explore. For instance, future studies can examine why the obtained results for the reaction time task were opposite from anticipated results. The preparation of the lie should be examined when considering this finding. If participants were not given any time to prepare the lie then it could have raised the level of cognitive effort that it took to lie successfully. Giving participants time to prepare their lies could have mitigated the effect that was being sought after for the reaction time task.

The incentive to lie should also be examined more directly. Raising incentive would be beneficial because it would create a more real-life scenario. One way this could be done is to have participants lie to a person. This study had participants recording lies and not lying to a person face-to-face. If an individual has to look at someone while they are telling the lie, it may make the task a little harder for them to complete. It should be harder for an individual to lie to another person because it adds pressure to the task. Presumably the liar will have to assess how

the individual being lied to is receiving the information being given to them. Therefore, the liar will be making assumptions about whether the individual believes their story. This means that the liar will have to attend to information from the listener (i.e., facial expressions) to determine if they are being convincing or not. While this would allow them to adjust their efforts and try harder to be believable if they assume the individual is not convinced, it also adds a considerable cognitive component that is not present in the current task. Additionally, if participants have to try to convince another person that they are not lying when they actually are, it could provide a little more incentive to perform the task to the best of their ability.

It is also possible that the visual reaction task was too easy to pair with the narratives. Previous research has used tasks that were more likely to have a higher cognitive demand than a simple reaction task. For example, participants in past studies were asked to tell their stories in reverse order, to maintain eye contact with an interviewer, or to give more detail (Vrij & Granhag, 2012), which may be more demanding tasks than simply pressing a button. Therefore, if the secondary task was a little harder it may bring out more signs of a higher cognitive demand when the participant is lying. If the secondary task is hard enough that the participant cannot perform the task effortlessly, then the participant should have to work harder to complete it. If the participant must work harder to complete it, then it would take up more of their cognitive resources, and therefore would have the desired effect on the primary task.

Future research can also examine the measures of disfluency and look at why there were significant differences for filled pauses in the single task conditions and not the dual task conditions. There may be other variables that are influencing these results. It is possible that the level of difficulty of the secondary task should have been higher, making the task a little harder or possibly a little more complex. It would also be beneficial to focus on whether lying can be

objectively measured in other ways. While cognitive based detection offers an alternative to arousal based detection, there must be solid measures to be able to gauge the amount of cognitive effort that a task requires and that an individual must exert to complete that task.

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APPENDICES

Appendix A

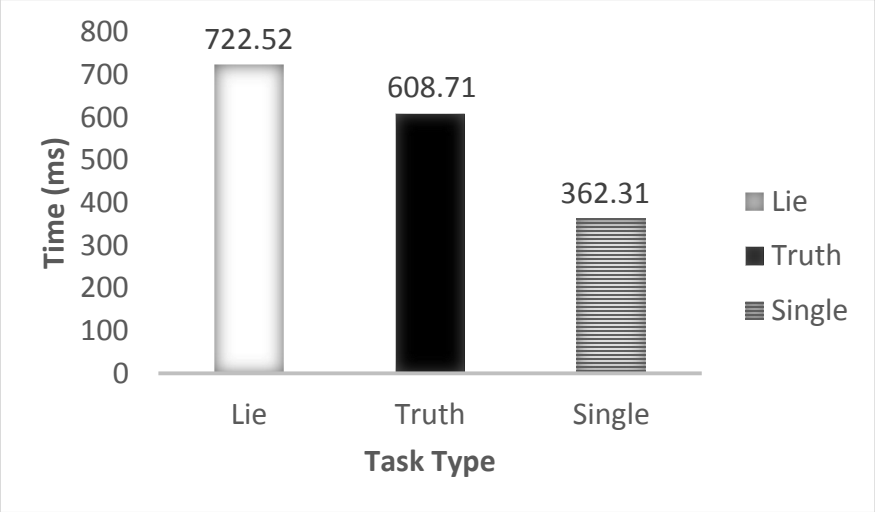

Figure 1. Reaction Times. This figure illustrates the average response time to the reaction task by story type.

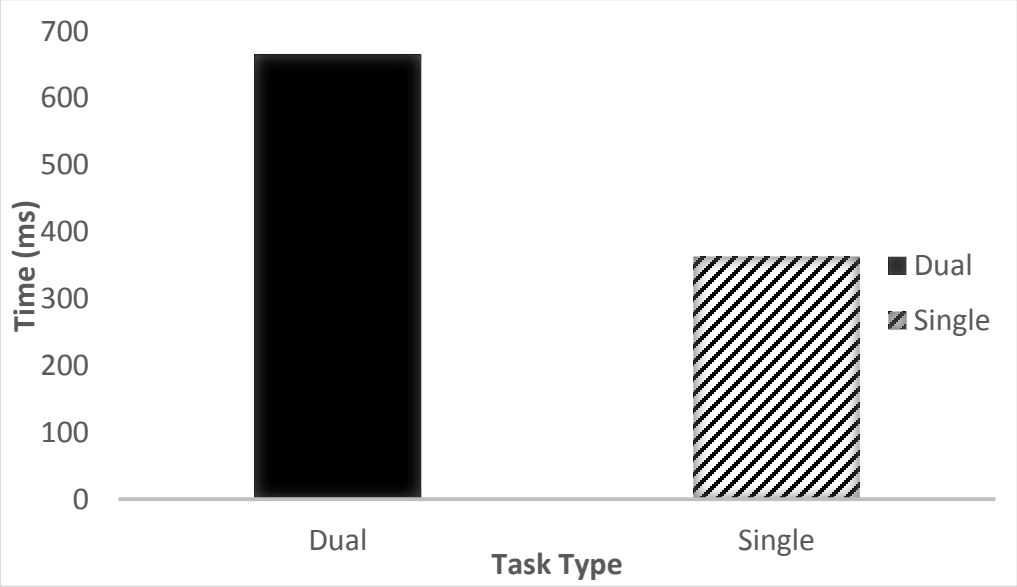

Figure 2. Reaction Times. This figure illustrates the average response time to the reaction task by task type.

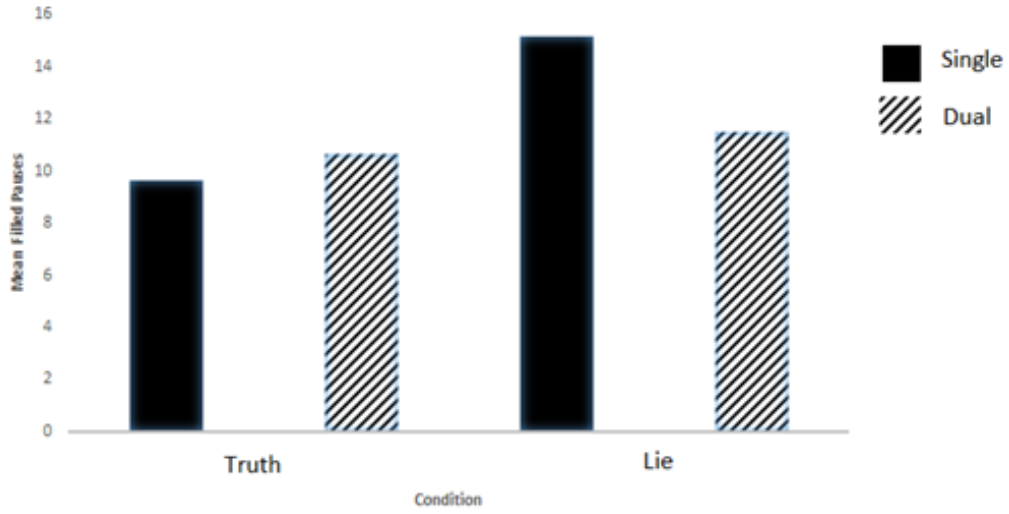

Figure 3. Filled Pauses. This figure illustrates the average number of filled pauses per condition.

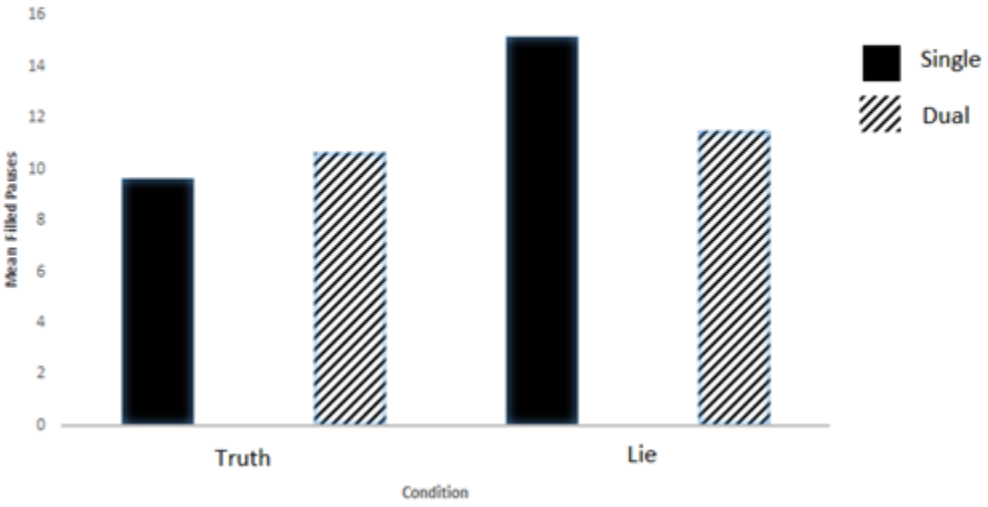

Figure 4. Unfilled Pauses. This figure illustrates the average number of unfilled pauses per condition.

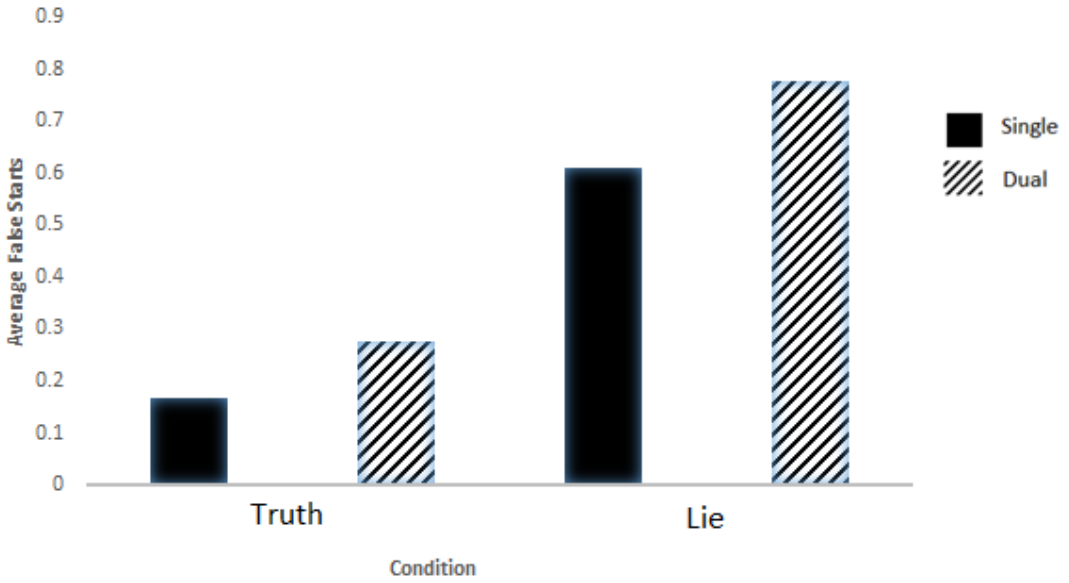

Figure 5. False Starts. This figure illustrates the average number of false starts per condition.

Appendix B

Life Inventory Events list

(Polage, 2004 & Garry et al., 1996)

Questions

1. Have you ever had to go to the emergency room late at night?
2. Have you ever found a $10 bill in a parking lot?
3. Have you ever had a birthday party?
4. Have you ever had a lifeguard pull you out of the water?
5. Have you ever broken a window with your hand?
6. Did you ever get in trouble for calling 911?
7. Did you ever crash your bicycle or tricycle?
8. Were you ever caught sneaking out of the house?
9. Have you ever gotten scolded for saying a bad word?
10. Did you ever shake hands with the president?
11. Have you ever fallen off playground equipment?
12. Did you ever break a favorite toy?
13. Have you ever been in a spelling contest at school?
14. What was your first day of college like?
15. Have you ever had a nightmare after watching a scary movie?
16. Have you ever experienced the loss of a loved one?
17. Did you ever get a bad haircut?
18. Were you ever responsible for taking care of a pet?

19. Have you ever been in an automobile accident?

20. Have you ever built a fort?

Appendix C

You will be asked to recall four events that you have experienced from this list and asked to create four fabricated stories based on four events that you have not experienced from this list. Your stories will be recorded. People will later listen to your stories to try to distinguish which of the stories were fabricated and which were truthful. Be sure to keep your story straight and try to be convincing when you are lying. Also, make sure to try and avoid making an impression that you are lying.

You will be given three minutes to recall or create your story. Make sure to have enough detail to talk for one and a half minutes. Once you are ready to begin press any key and start to tell your story.

Note: Added verbally to the instructions, “Make sure you talk for as long as you can. The computer will prompt you when the time is up. Try to talk for that entire time. Don’t forget about the reaction task.”