Who remembers more?
An exploratory study on the influence of biological sex on humans' memory ability

by

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Abstract

This paper investigated the effects of trustworthiness of visual stimuli on humans' ability to remember stimuli as well as the influence of sex on a person's ability to memorize visual stimuli. In performing this research, participants were first exposed to a pre-trial in which neutral stimuli were presented, after which they viewed an altered version of this same set of images where some were new and some previously viewed. Following this, participants had to indicate whether they had viewed the presented stimulus before. This pre-trial was followed by a test phase in which participants were exposed to a set of images consisting of devices, faces and scenes, after which they viewed an altered version with previously viewed stimuli and new stimuli during which they indicated whether they had seen the presented stimulus before. No difference was found between the sexes and their ability to recognize either untrustworthy or trustworthy stimuli, although results showed that people´s ability for memorizing impacted the ability to discriminate between old and new stimuli presented during the test phase.

Introduction

Trust is one of the most important foundations for various kinds of human interaction with objects and people(Fett et al., 2012; Lankton, Harrison & Tripp, 2015). Over the course of multiple studies, trust has been defined in various ways. One of these definitions has formulated trust as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intention of the behaviour of another" (Rousseau, Sitkin, Burt, & Camerer, 1998). This definition has been chosen as it emphasises the aspect of expectations humans have on the actions or performance of others. Although some studies have suggested that trust is exclusive to interactions between humans and that it cannot be built in a relationship towards technology, more and more researchers have started to agree on the fact that, despite differences between interpersonal interactions and exchanges with technology, a form of trust can be established between humans and technology (Schneiderman, 2000; Lankton, McKnight, & Tripp, 2015).

In addition to the establishment of trust between humans and technology, Lankton et al. (2015) have posited that humans assess the trustworthiness of technology in different manners, depending on the amount of humanness displayed by technology. Factors such as voice capabilities and animation can influence the form of trust humans have towards it, where they assess it based on either competence and integrity as a system, whereas a lack of human-like features can cause it to be assessed based on its functionality and the ability to perform the task for which it was designed.

Building on the way people learn to trust and interact with technology, the term 'Trust towards systems' (TTS) was defined as " the result of a dynamic mechanism of people's experience with technology. This dynamic starts before a direct interaction with a system, and continues to change throughout the interaction and on the basis of the cumulative experience." (Borsci, Buckle, Walne, & Salanitri, 2018)

When looking at the different forms of trust such as TTS, there is a clear distinction to be made between trust, untrust and distrust. Over the course of several studies, distrust has been conceptualised as a violation of trust, an opposite of trust, or low levels of trust (Bies & Tripp, 1996; Elangovan & Shapiro, 1998; Dirks & Ferrin, 2001; Gilbert & Tang, 1998). A study by Frederiksen (2011) suggests that distrust is built on the previous experiences of a person with

regard to another person or group. In this sense, distrust towards people and by extension to artefacts and technology is a negative sense of trust after interaction took place.

Differently from distrust is the concept of untrust. Despite a lack of research with regard to untrust towards technology, untrust towards people is defined as a measure of how little a trustee is trusted (Marsh & Dibben, 2005). This concept entails that untrust is not an opposite of trust but rather a lack of trust based on the beliefs and expectations the truster has before interaction took place. This paper attempts to investigate the concept of untrust and with a particular focus on untrustworthy technology and people's ability to recognize untrustworthy technology.

Related to the concept of trust, studies in the domain of evolutionary psychology have investigated the concept of cheater detection and their applications. Studies have shown that people have a general propensity towards recognizing and remembering cheaters or defectors better and faster than co-operators by looking at faces (Okubo, Ishikawa, & Kobayashi, 2018; István, 2010; Yamagishi, Tanida, Mashima, Shimoma, Kanazawa, 2003; Kroneisen, 2018).

Previous research has shown that humans have developed a general ability to remember and recognize potentially threatening situations better than those that are seemingly harmless as a self-preservation mechanism (McBride, Brandon, & Zimmerman, 2013; Chunna & Zhijun, 2019). For this paper, it will be investigated whether this evolutionary self-preservation mechanism can be applied to modern technology as well as faces and different types of scenes. Scenes in this case also have an important role as research has shown that this type of visual stimulus allows the brain to make certain expectations based on previously stored representations, which then influences the recognition of a stimulus (Bar, 2007).

For example, a study by Mattarozzi, Todorov and Codispoti (2015) had shown that the emotional context and assumed trustworthiness influenced the encoding process for a given stimulus, which for this study was a face. When a stimulus was presented with an emotionally loaded context or described with either something pleasant or unpleasant, it influenced the encoding and retrieval process to such a degree that participants remembered semantic details and, in some cases, even specific episodic details of that person.

Moreover, a study by Golesorkhi (2006) indicated that there is a discernible difference when looking at the way males and females assess the trustworthiness of their peers in a work setting. This study will aim to explore the possibility of extrapolating this information and investigate whether there is a difference between males and females and their ability to memorize

(un)trustworthy stimuli. Another study by Pinto, Dutra, Filgueiras, Juruena and Stingel (2013) has also indicated that there appears to be a difference between the sexes and their ability to recognize certain types of facial expressions more. Specifically, males appear to be better at recognizing happy facial expressions, whereas females seem to be better at recognizing sad facial expressions. It could be assumed that the combined results from the aforementioned studies may indicate a difference between the sexes and their ability to remember certain types of trustworthy or untrustworthy stimuli.

Ultimately, the assumption was made that the (un)trustworthiness of stimuli may affect the recognition thereof in a memory-based experiment, where the expectation is that untrustworthy stimuli will have a higher probability of being remembered and recognized. Furthermore, the possibility of differences between the two sexes will be explored with regard to their memory ability. In summary, the present work focuses on investigating the influence of biological sex and (un)trustworthiness on humans' memory ability with regard to different types of stimuli.

Methods

Design

This study was an exploratory research with a correlational design regarding the influence of the (un)trustworthiness of stimuli and memory ability of participants on someone's ability to discriminate between old and new stimuli. Furthermore, the participants' biological sex was taken into account to see whether this influenced the recognition of old and new stimuli.

Participants

A total of 83 participants were recruited for this study. These participants were between the ages of 19 and 73, with a mean age of 28 and SD = 11.931, and consisted of 41 males and 42 females. Participants for this study were obtained through convenience sampling.

Materials

Materials used for this study included PsychoPy3, which was required for the experiment and the program IBM SPSS 26 which was used for data analysis. Moreover, a questionnaire on Qualtrics was employed to obtain the demographics of the participants. With regards to the experiment that

was ran on Psychopy3, the stimuli that were utilised here were obtained from either multiple standardized databases with regards to the (un)trustworthy stimuli or consisted of neutral flags. The used databases were the Chicago Face Database, from which 20 faces were rated less trustworthy (cheaters) and 20 faces which were rated trustworthy (co-operators), the SMID from which another 40 images were selected from which 20 were ranked immoral and 20 moral (Ma, Correll & Wittenbrink, 2015; Crone, 2018). Finally, there were 40 images of consumer products, selecting devices that were reported as problematic and dangerous to people's lives (untrustworthy), and devices that are on the market from 2017 and were never reported for issues or risks in usage (trustworthy) (CPSC, n.d.) (see Appendix).

Procedure

Before starting the experiment, participants filled out a consent form on Qualtrics. After this, the experiment in Psychopy3 commenced, consisting of two stages. The first stage consisted of the pre-trial, where participants viewed a set of 20 flags. After this, they were asked to view an altered set of images with previously viewed and new, unseen, stimuli where they were asked to indicate whether they had seen the presented stimuli before. This allowed for the creation of a baseline memory ability index per participant. After the pre-trial had been completed, the second stage of the experiment started. During this second stage, the participants first viewed a set of 60 images consisting of different (un)trustworthy faces, scenes and devices. Participants were simply asked to focus and try to remember as many stimuli as possible.

After viewing this set of 60 images, a 30-minute break was held in which the participants viewed a Tedxtalk - The power of vulnerability. Following the 30-minute break, the participants again viewed a set of stimuli with some previously viewed and other stimuli that were new, being asked to indicate whether they had seen these stimuli before.

Finally, after completion of this experiment, participants were requested to fill in a questionnaire on Qualtrics in which they answered questions regarding their demographics, a series of statements regarding their attitude towards technology and their dependency on it as well as questions involving the Big Five personality traits.

Due to the circumstances caused by COVID-19, the experiment was also performed remotely over internet calling applications such as Skype and Google Hangouts. In the cases where

this method was applied, the researcher shared their screen and allowed the participant to respond to the images shown on the researcher's screen. The researcher would then fill in these responses until the experiment was completed. The questionnaire, which due to their online availability on other devices, was still filled in by the participant.

Data analysis

Analyses included frequencies and descriptives for age, sex and general scores on (un)trustworthiness recognition.

In order to analyse differences between the different types of visual stimuli, objects, faces and scenes, the performance scores of participants were divided in separate groups in line with the type of stimulus that was presented. In order to have a concrete value for the participants abilities, sensitivity was calculated in the form of the discriminability index (d'). A higher value for d' indicated an increased ability in a participant to recognize previously presented stimuli. This discriminability index was calculated and adjusted as proposed by Macmillan and Creelman (2005). This allowed for the creation of four groups, one for each stimulus type as well as an overall performance score on all stimuli. This was done in order to check for within-subjects differences between the different types of stimuli. The groups mentioned above were named FaceDetectors, SceneDetectors, DeviceDetectors and Overalldetectors, in line with the type of stimulus presented. Moreover, each individual group was split in two groups which indicated whether the presented stimulus was classified as trustworthy or untrustworthy (i.e. FacesUntrustworthy and FacesTrustworthy). This allowed for analyses regarding differences between the trustworthiness of a stimulus and what impact this may have had on the performance of participants.

The aforementioned groups' d' values were created by subtracting their d' scores for untrust off the scores for trust. These scores then indicated whether people were better at recognizing untrustworthy stimuli or trustworthy stimuli, where scores above 0 indicated they were better at recognizing untrustworthy stimuli and scores below 0 indicated that people were better at recognizing trustworthy stimuli.

Specifically, the d' values close to 0 indicate that the participants generally struggled with correctly recalling the stimuli. Values between 0 and 1 indicate that the participants were able to discriminate the stimuli to a minor degree but still made a large number of mistakes. Values

between 1 and 2 indicate a participant that was generally quite able to correctly distinguish between stimuli they had or had not seen before, whereas a value of 2 indicates that the participant was exceptionally good at discriminating between previously viewed stimuli and new stimuli (Macmillan & Creelman, 2005).

Repeated measures ANOVAS were used to analyse people's ability to recognize (un)trustworthy scenes, faces and objects compared to their base memory ability. For these repeated measures ANOVA, sex was used as the between-subjects factor, and their ability to memorize stimuli (d' of the pre-trial) was used as a covariate in order to shed light on the predicting effect of memory ability on the performance on memory related tasks such as this experiment.

Results

Table 1

Descriptive statistics of d'

	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Pre-trial	83	.15	1.96	1.50	.04	.39
Overall Trustworthy	83	.00	2.15	1.29	.05	.50
Overall Untrustworthy	83	.00	2.20	1.34	.06	.50
Faces Trustworthy	83	-.89	1.80	.84	.06	.59
Faces Untrustworthy	82	-.40	1.94	.90	.06	.55
Scenes Trustworthy	82	-.30	2.06	1.30	.05	.47
Scenes Untrustworthy	83	-.41	2.06	1.19	.06	.57
Devices Trustworthy	81	.00	2.06	1.13	.05	.48
Devices Untrustworthy	82	-.48	2.06	1.15	.06	.52

Descriptive statistics of d' on the pre-trial seemingly indicated that participants had no discernible issues with discriminating between old and new stimuli (M = 1.50; SD = .39; SE = .04). Overall, the values for d' for all stimuli was slightly lower than that of the pre-trial, but still above one. This effect also appeared in the overall stimuli, where untrustworthy images were remembered more often than trustworthy images, indicated by a higher mean of d' on untrustworthy images (Table 1). In summary, descriptive statistics indicated some differences for the trustworthiness of a stimulus and a participants ability to discriminate between old and new stimuli, although this effect was not supported by further testing as there were no significant results that indicated a similar effect.

In performing a repeated measures ANOVA with sex as between-subjects factor, the d'of the pre-trial as covariate and the d' values of trustworthy scenes and untrustworthy scenes as factors, there appears to be a significant within-subjects effect for the pre-trial on people's ability to recognize scenes, $F(1,79) = 12.7$, $p = 0.001$, $\eta_p^2 = 0.138$ (Table 2). Moreover, in performing a two-level repeated measures ANOVA in which one level indicated the stimulus type and another indicated whether the stimulus presented was trustworthy or untrustworthy, using all stimulus groups (FacesUntrustworthy, FacesTrustworthy, ScenesUntrustworthy, ScenesTrustworthy, DevicesUntrustworthy and DevicesTrustworthy) as factors, indicated that the d' of the pretrial was able to predict the ability of participants to discriminate between old and new stimuli in general, $F(1,80) = 8.5$, $p < 0.0005$, $\eta_p^2 = 0.099$ (Table 3). These suggests that the pre-trial scores can be used as a predictor for their performance on memory related tasks where a higher score on the pre-trial indicates a higher score on overall performance during the test phase.

Table 2

Test of Within-Subjects effects on ScenesDetection

Source	df	F	Sig.	Partial Eta Squared
DprimePRe (Pre-trial)	1	12.693	.001	.0138
Sex	1	.311	.579	
Error	79			

Note. The only stimulus type participants viewed here were scenes. Therefore, the performance scores for devices and scenes are not included.

Table 3

Test of Within-Subjects effects on OverallDetection

Source	Df	F	Sig.	Partial Eta Squared
Intercept	1	29,303	.000	,276
DprimePRe (Pre-trial)	1	8.472	.000	.099
Sex	1	.005	.942	.010
Error	80			

Note. This table covers all different types of stimuli and, therefore, takes the average performance scores for participants

Discussion

This study aimed to explore the differences between males and females and their ability to discriminate between old and new stimuli as well as the influence of a person's memory ability on their ability to discriminate between old and new stimuli. Moreover, it was investigated whether the trustworthiness of stimuli had an influence on participants´ ability to discriminate between old and new stimuli and if there was a difference in effect depending on the type of visual stimulus presented, in this case faces, devices and scenes. Results, limitations and options for future research will be further detailed below.

One result that warrants further investigation is the insignificance found between male and female performance on the memory related task of this study as it seems to be contradictory to findings by Harness, Jacot, Scherf, White and Warnick (2008) who suggest that there is a difference between males and females in recognition for working memory tasks. In contrast to this, there seems to be an effect of people's general ability to remember visual stimuli and their recognition of both general visual stimuli and scenes in specific.

Limitations

Certain limitations to this study, due to time constraints and COVID-19 may have had an impact on the results that the experiment yielded. One suggestion for future research would involve a longer break between the several trials of the experiment. Rather than having a pre-test phase immediately followed by the trial with (un)trustworthy stimuli, it might be beneficial to have gathered data on the pre-trial and the trial on separate occasions. Moreover, a controlled environment was more difficult to obtain as a large part of the experiment was performed with participants residing in their own homes which, at times, led to disturbances and distractions.

Future Research

Future research could be aimed at the physiological and psychological aspects that may influence the differences between sexes. Building on a study by Grimault et al. (2009), an option may be to employ fMRI or MEG during the exposure and testing phases to investigate whether there is a difference in neurological activity based on the types of visual stimuli presented and if this influences the encoding process, similar to an experiment performed by Peth et al. (2015). This

opens up more possibilities for exploring gender differences and may give a more concrete image of what causes these differences.

Moreover, an exploratory study on the underlying neurological mechanisms behind humans' inclination towards remembering untrustworthy stimuli more may yield interesting results. Studies such as the one performed by Mattarozzi et al. (2015) already showed that this tendency to remember untrustworthy stimuli exists, but fail to explain why this effect takes place or what processes are involved. Using MEG or fMRI, again, to visualise neuroactivity whilst participants view (un)trustworthy stimuli may shed more light on what cortices are involved and whether there is a difference between males and females in this regard.

Conclusion

This study has found no significant differences between the sexes and their ability to memorize or recognize (un)trustworthy stimuli, although it appears that performance on the pre-trial with flag stimuli was predictive with regard to performance on the stimuli employed in the test phase. Future experiments with a focus on the process of encoding and retrieving memories could potentially provide more insight in the neurological mechanisms associated with what causes certain stimuli to be remembered more than others. Perhaps also focussing on one specific type of stimulus divided in subgroups, e.g. technology as main type with different kinds of consumer electronics, may shed more light on this subject which in turn may have interesting applications for product design, neuroergonomics and User Experience.

References

Bar, M. (2007). The proactive brain: using analogies and associations to generate predictions. *Trends in Cognitive Sciences, 11*(7), 280-289. doi:10.1016/j.tics.2007.05.005

Bies, R. & Tripp, T. (1996). Beyond distrust: "getting even" and the need for revenge. In R. Kramer & T. Tyler *Trust in organizations: Frontiers of theory and research* (pp. 246-260). Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781452243610.n12

Borsci, S., Buckle, P., Walne, S., & Salanitri, D. (2019, 2019//). *Trust and Human Factors in the Design of Healthcare Technology.* Paper presented at the Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018), Cham.

Chunna, H., & Zhijun, L. (2019). The Survival Processing Advantage of Face: The Memorization of the (Un)Trustworthy Face Contributes More to Survival Adaptation. *Evolutionary Psychology*. doi:10.1177/1474704919839726

CPSC.gov. (n.d.). Retrieved February, 2020, from https://www.cpsc.gov/

Crone, D. (2018, November 28). The Socio-Moral Image Database (SMID). Retrieved from osf.io/2rqad

Dirks, K. T., & Ferrin, D. L. (2001). The Role of Trust in Organizational Settings. *Organization Science, 12*(4), 450-467. doi:10.1287/orsc.12.4.450.10640

Elangovan, A. R., & Shapiro, D. L. (1998). Betrayal of Trust in Organizations. *The Academy of Management Review, 23*(3), 547-566.

Fett, A. J., Shergill, S. S., Joyce, D. W., Riedl, A. M., Strobel, M., Gromann, P. M., & Krabbendam, L. (2012). To trust or not to trust: The dynamics of social interaction in psychosis. *Brain, 135*(3), 976-984.

Frederiksen, M. (2011). Distrust and Mistrust: Lessons from a Low Trust Minority. *Comparative Sociology, 10*(2), 248-280. doi:10.1163/156913311X56658

Gilbert, J. A., & Tang, T. L.-P. (1998). An Examination of Organizational Trust Antecedents. *Public Personnel Management, 27*(3), 321-338. doi:10.1177/009102609802700303

Golesorkhi, B. (2006). Gender differences and similarities in judgments of trustworthiness. *Women in Management Review, 21*(3), 195-210. doi:10.1108/09649420610657380

Grimault, S. p., Robitaille, N., Grova, C., Lina, J.-M., Dubarry, A.-S., & Jolicœur, P. (2009). Oscillatory activity in parietal and dorsolateral prefrontal cortex during retention in visual

short-term memory: Additive effects of spatial attention and memory load. *Human Brain Mapping, 30*(10), 3378-3392. doi:10.1002/hbm.20759

Harness, A., Jacot, L., Scherf, S., White, A., & Warnick, J. E. (2008). Sex differences in working memory. *Psychological reports, 103*(1), 214-218.

Ho, H. I., Hirose, S., Kuspa, A., & Shaulsky, G. (2013). Kin recognition protects cooperators against cheaters. *Current biology : CB, 23*(16), 1590-1595. doi:10.1016/j.cub.2013.06.049

István, H. d. (2010). Subconscious recognition of cheater faces in a visual discrimination task. *Frontiers in Neuroscience, 4*. doi:10.3389/conf.fnins.2010.10.00163

Kroneisen, M. (2018). Is he important to me? Source memory advantage for personally relevant cheaters. *Psychonomic Bulletin and Review, 25*(3), 1129-1137. doi:10.3758/s13423-017-1345-1

Lankton, N. K., Harrison Mcknight, D., & Tripp, J. (2015). Technology, humanness, and trust: Rethinking trust in technology. *Journal of the Association of Information Systems, 16*(10), 880-918.

Ma, D., Correll, J., & Wittenbrink, B. (2015). The Chicago Face Database: A Free Stimulus Set of Faces and Norming Data. *Behavior Research Methods, 47*, 1122-1135.

Macmillan, N. A., & Creelman, C. D. (2005). *Detection theory : a user's guide* (2nd ed. ed.). Mahwah, N.J.: Lawrence Erlbaum Associates.

Marsh, S., & Dibben, M. (2005). *Trust, Untrust, Distrust and Mistrust – An Exploration of the Dark(er) Side* (Vol. 3477).

Mattarozzi, K., Todorov, A., & Codispoti, M. (2015). Memory for faces: the effect of facial appearance and the context in which the face is encountered. *Psychological Research : An International Journal of Perception, Attention, Memory, and Action, 79*(2), 308-317. doi:10.1007/s00426-014-0554-8

McBride, D. M., Thomas, B. J., & Zimmerman, C. (2013). A test of the survival processing advantage in implicit and explicit memory tests. *Memory & Cognition, 41*(6), 862-871. doi:10.3758/s13421-013-0304-y

Okubo, M., Ishikawa, K., & Kobayashi, A. (2018). The cheek of a cheater: Effects of posing the left and right hemiface on the perception of trustworthiness. *Laterality: Asymmetries of Body, Brain, and Cognition, 23*(2), 209-227. doi:10.1080/1357650X.2017.1351449

Peth, J., Sommer, T., Hebart, M. N., Vossel, G., Büchel, C., & Gamer, M. (2015). Memory detection using fMRI - Does the encoding context matter? *NeuroImage, 113*, 164-174. doi:10.1016/j.neuroimage.2015.03.051

Pinto, B. M. de C., Dutra, N. B., Filgueiras, A., Juruena, M. F., Stingel, A. M. (2013). Gender differences among undergraduates in the recognition of emotional facial expressions. *Avances en Psicología Latinoamericana, 31*(1), 200-222.

Rousseau, D. M., Sitkin, S. B., Burt, R. S., & Camerer, C. (1998). Introduction to Special Topic Forum: Not so Different after All: A Cross-Discipline View of Trust. *The Academy of Management Review, 23*(3), 393-404.

Shneiderman, B. (2000). Designing Trust into Online Experiences. *COMMUNICATIONS- ACM, 43*(Part 12), 57-59. Yamagishi, T., Tanida, S., Mashima, R., Shimoma, E., & Kanazawa, S. (2003). You can judge a book by its cover: Evidence that cheaters may look different from cooperators. *Evolution and Human Behavior, 24*(4), 290-301. doi:10.1016/S1090-5138(03)00035-7

Appendix

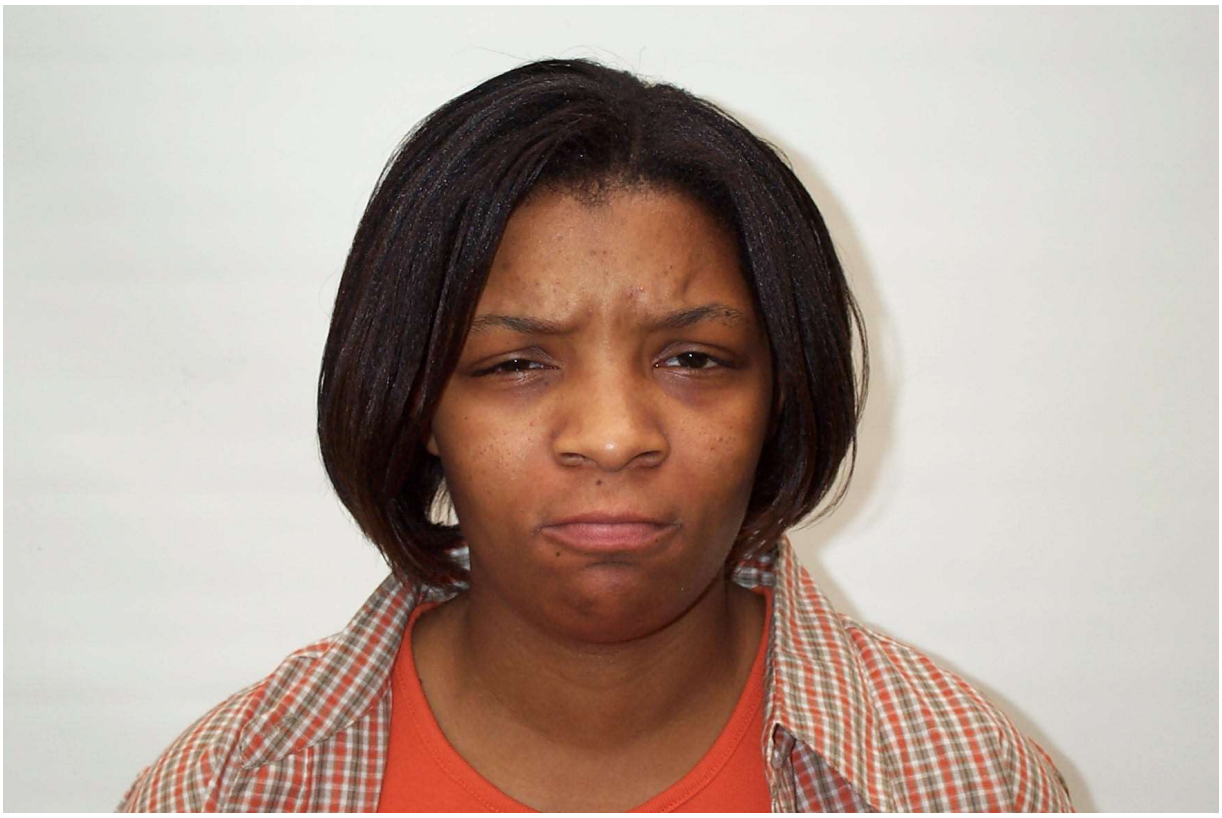

Figure 1. *An example of an untrustworthy stimulus used in the experiment*