Investigation of Cultural Bias Using Physiological Metrics

Renee Rigrish and Mary Fendley

Abstract In today's world, many business transactions and interactions are conducted cross-culturally. In a business meeting, it is essential avoid a major cultural faux pas in order to not offend your business partners. Individuals must adjust their approach to a situation to create a cultural match. In adjusting this approach, cognitive biases are a potential result in cross-cultural scenarios. We investigate the Mirror Imaging Bias, which was found to be a common result of a shortcut to decide how to act in a situation. Physiological metrics were used to see if biases can be detected in a non-invasive manner. It was found that pupil diameter is a reliable indicator of when Mirror Imaging Bias is present. By understanding how individuals process information and are influenced by Mirror Imaging Bias, we can help create applications as well as provide training to help avoid cultural faux pas.

Keywords Mirror image bias · Cognitive bias · Heuristic · Cultural bias · Physiological measures · Psychophysiological

1 Introduction

With international business becoming a normal part of business practice, it has become important to know how to create strong relations by respecting business customs and practices. While we may believe that an unconscious act of crossing a leg over the knee is harmless, other cultures may see this as an intentional act of disrespect [1]. To prevent cultural faux pas from happening, businesses often hire cultural liaisons which work as not only interpreters, but experts and advisors about do the "dos and don'ts" of each culture.

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These cultural faux pas can happen to small businesses and world leaders alike [2, 3]. It is apparent that while some acts are seen as positive or neutral in one country, they could potentially be very offensive in another county. It is already known that cultural bias exists as people are taught customs of their nation and must become familiar with new customs when visiting another nation. If cultural bias is detectable, it would suggest that prior consultation with a different nation's customs is beneficial before traveling abroad or that a cultural liaison may be required to help assist with cultural traditions.

The main goals of this study are as follows: to find if Mirror Imaging Bias has an influence in making decisions in culturally diverse situations, and to find if physiological measures could detect its presence. The hypothesis is that there will be a greater workload present when Theory of Mind is used to assess how to act in a situation over the influence of Mirror Imaging Bias.

2 Mirror Imaging Bias and Theory of Mind

Mirror Imaging Bias is described as "the tendency to interpret the actions of others in one's own terms" [4]. When people try to view a scenario and make conclusions based on their own personal experiences, they make an assumption that others think the same as themselves and share similar experiences, and thus use Mirror Imaging Bias. Salchak noted that is the most common bias that is commonly experienced by intelligence analysts and could be dangerous in different situations [5].

Theory of Mind is the ability for an individual to correctly understand other individuals' mental states in a situation including their different beliefs, intents, desires, knowledge, etc. [6]. While one individual may have a view on the situation, using Theory of Mind means that they understand the view of a different person who may have a very different view than their own. Most individuals are able to achieve this ability by the age of four [7].

One reason for Mirror Imaging Bias to happen is the failure of Theory of Mind. Sometimes, instead of being able to understand another person's beliefs, individuals may project their own in order to decide an appropriate action. It is a mental shortcut an individual may take in order to avoid a high cognitive load. Employing Theory of Mind has a higher cognitive load because it requires individuals to comprehend and understand the intentions and actions of another individual. Mirror Imaging Bias would bypass the process where another person's views would be taken in account; instead an individual would carry out a scenario based on their own views which is a more natural response.

In Schaller's paper Failed Mirroring as a Cultural Phenomenon, she states that "a cultural dimension also exists in mirroring or failed mirroring. When, in daily human interactions, persons have reflected back to them not themselves but the cultural assumptions of others, they experience failed mirroring" [8].

Cultural mismatch and the use of Mirror Imaging Bias as opposed to Theory of Mind can lead to misunderstandings within a business setting. By assuming and projecting your own cultural practices on another culture, you are using Mirror Imaging Bias.

3 Methodology

This study was designed to test how participants interact with different cultural scenarios in order to determine what type of bias is present. Answers provided by the participant were recorded and analyzed.

As stated before, Mirror Imaging Bias and Theory of Mind can occur when trying to predict the actions of other individuals. Mirror Imaging Bias occurred when the participant would give an answer on how a person should act based on their own personal experience. Essentially, they answered the question based on how they would act if they were in that situation. When answering for the other individuals in the situation, the answers will be compared to how they answered for themselves in the same situation to see if they exhibit their own cultural bias as opposed to attempting to modify their cultural lens to adjust to the mismatch. If they are able to project Theory of Mind correctly, the participant would have the ability to take the perspective of a person from a separate cultural background. This would be apparent if the participant is able to adjust their cultural mismatch to predict appropriate actions of the people in the scenario.

3.1 Participants

Fifty participants aged 18 to 40 were recruited from the Wright State University community. These subjects were comprised of the following groups: 20 Americans (10 male, 10 female), 20 Indians (10 male, 10 female), 7 Middle Eastern (4 Males, 3 Females), and 3 Chinese (2 Male, 1 Female). Due to a data recording error, one American female's results were not recorded correctly and thus the data was unusable. Another Indian female was found to answer the questions with response times of less than 0.1 s which would not allow time to read and comprehend the questions. Her data was omitted from analysis due to these impractical response times not allowing a genuine response.

3.2 Apparatus

Testing of the scenarios was performed at Wright State University (WSU) and the study was approved by the WSU Institutional Review Board (IRB). The software

used included the Tobii Studio eye tracker and the CAPTIV-L7000 system. Tobii was used to collect and record subjects' eye tracking information such as gaze, number of fixations, and pupil dilation while CAPTIV-L7000 collected galvanic skin response (GSR), heart rate variance (HRV), and electromyography (EMG) of the medial frontalis and the right-unilateral EMG of the orbicularis oculi. Although CAPTIV was used in the study, we are limiting the discussion to the results of the eye-tracking here.

3.3 Stimuli

The participants were asked to view the scenario with audio about what is happening in the picture. They were then asked a question about the scenario from the perspective of the "self" and "other". This helps determine how an individual would act naturally in a situation and if they are able to use Theory of Mind when answering for the other culture.

Scenarios were created based on research from several etiquette guides based on how to do proper business in each of these regions. Actions in the scenarios included dining etiquette, greetings, conversational etiquette and meeting etiquette.

3.4 Procedure

Participants start the experiment by filling out an informed consent. Once consent was received, the CAPTIV sensors were placed on the individual and tested for functionality. As familiarity with cultures plays a significant role in this study, participants were asked in a pre-questionnaire about what cultures they identify with, cultures they have been exposed to, as well as what level of exposure occurred. Participants also noted how long they have been exposed to that culture. A second pre-questionnaire was also administer to determine an individual's cultural awareness. The eye tracking system was then calibrated to the participant.

Before being presented with the experimental stimuli, participants viewed a demonstration of a scenario in which they were asked to answer a simple question about the picture presented.

There were 10 images of each culture which totaled 30 images presented. Participants were exposed to the each of the images with an accompanying audio describing the actions in each scenario. Each audio segment lasted between seven and twelve seconds. The culture being presented was either stated in the audio segment and/or was shown by the people present in each image. After each of the audio files were completed, the participant was presented with a question which was superimposed on to the image. The images were randomized within each cultural group. The order in which the cultures were presented was also randomized.

Each image was presented twice in order to explore the differences of answering questions about the self and answering questions about other people's actions in accordance to the culture presented. Since participants were shown each image twice, this totaled 60 scenarios presented. Participants responded by using the keyboard with the up arrow key corresponding to "Yes" and the down arrow key corresponding to "No." Image order was randomized in order to minimize a learning effect.

A post questionnaire was administered to determine how familiar the participants were with each of the presented cultures. Participants also indicated if they used any information about the cultures to make their decisions.

3.5 Research Components

In this study, the following cultural groups were chosen; American, Indian, Middle Eastern and Chinese. These cultures were chosen based off of the cultural populations present at Wright State University. The scenarios comprised of scenes from business with individuals from India, the Middle East, and China.

Cognitive load is described as a level of perceived effort which may be associated with cognitive tasks such as learning thinking and reasoning [9]. Cognitive load may also be measured using different physiological and performance metrics. The metrics analyzed in this paper are as follows: pupil diameter, number of fixations, response time.

Pupil Diameter and Number of Fixations. Pupil diameter measures the dilation of the eyes in millimeters. The pupil diameter of the left and right eyes were measured using Tobii Studio eye tracker. Pupil size has shown to directly reflect processing load and mental effort in individuals [10].

One study connects pupil diameter with cognitive load used a Stroop test to control the cognitive involvement of the participants [9]. The average pupil diameter over a task was measured and then different algorithms were used to predict which level of the cognitive load was present during that time. It was found from these algorithms that the pupil diameter has an average rate of 85.86 % at predicting the correct cognitive load present. One algorithm had a success rate of 89.08 % to classify the cognitive load [9]. This rate of accuracy shows that the pupil diameter is a reliable metric to measure cognitive load. Through various studies, it was found that pupil diameter is a reliable metric to use when measuring the cognitive load present during a task.

A fixation is where the eye remains still for a period of time to look at one spot in the field of vision [11]. It was found that "participants would show additional fixations on the units reflecting additional cognitive effort to inhibit the interfering information in incompatible trials" [12]. Fixation count was also found to be at its' highest when there was either a highly complex task or the interface was complex itself [13]. It is also important to note that individuals fixate more often on

informative objects within a scene in order to gather more information [14]. This leads to a conclusion that more fixations could indicate the presence of a higher level of cognitive load.

4 Results

The bias of each individual was determined by comparing how an individual answered the scenario when answering for "self" perspective versus answering the scenario based on "other" perspective.

If the answers for "self" perspective and "other" perspective matched, this indicates that the individual did not change their way of thinking in the scenario and thus Mirror Imaging Bias is implemented. If the answers for "self" perspective and "other" perspective did not match, this indicates that the individual used Theory of Mind to try to answer the scenarios from the perspective of the individual.

Overall results showed that Mirror Imaging Bias (62.45 %) was used by participants almost twice as frequently as Theory of Mind (37.55 %).

Participants stated that when answering questions on a cultural scenario they were not familiar with, they would apply their own experiences where they have dealt with a situation in their personal lives in accordance to their culture.

4.1 Response Time

Response times were calculated as the time when the question first appeared on the screen to when the participant chose an answer.

A one-way ANOVA analysis showed that for the Response Time there was a significant difference between bias types (p-value = 0.0380) when using an alpha of 0.05. Mirror Imaging Bias exhibits a lower response time (mean value of 3.08 s) than Theory of Mind (mean value of 3.52 s). The power of the test for bias was 0.5462. The Least Square means plot in Fig. 1 shows that for each culture that Theory of Mind has a higher response time with the exception of the Chinese group.

4.2 Pupil Diameter

Pupil diameters were taken at the time that the participant answered a question. Along with a baseline pupil diameter. Baseline pupil diameter was subtracted from the pupil diameter at the time when the participants answered the questions in order to account for differences in pupil diameters between participants. This

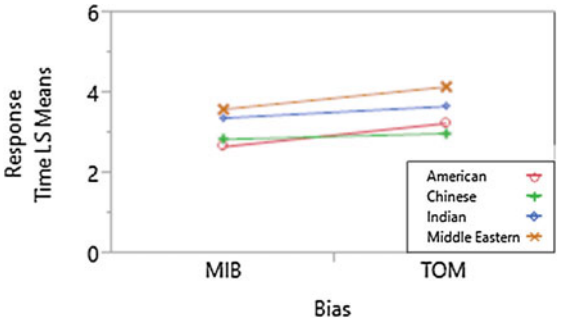

Fig. 1 LS means plot comparing response times for each culture according to MIB and TOM shows a trend of TOM consistently higher than MIB for all groups except Chinese

measurement will be referred to as Pupil Delta. The unit for the pupil diameters is in millimeters.

A one-way ANOVA analysis showed that for the Left Pupil Delta there was a significant difference between the bias types (p-value < 0.0001) when using an alpha of 0.05. There was no significant difference between the interaction of culture and bias (p-value = 0.2831). There is a significant difference between Mirror Imaging Bias and Theory of Mind where Mirror Imaging Bias shows a lower change in pupil diameter (mean value of 0.41 mm) than Theory of Mind (mean value of 0.49 mm). The power of the test for bias was 0.9834. The Least Square means plot in Fig. 2 shows that for each culture that Theory of Mind has a higher difference in pupil diameter.

A one-way ANOVA analysis showed that for the Right Pupil Delta there was a significant difference with the bias types (p-value < 0.0001) when using an alpha of 0.05. There is a significant difference between Mirror Imaging Bias and Theory of Mind where Mirror Imaging Bias shows a lower change in pupil diameter (mean value of 0.46 mm) than Theory of Mind (mean value of 0.54 mm). The power of the test for bias was 0.9906. The Least Square means plot in Figs. 3 show that for each culture that Theory of Mind has a higher difference in pupil diameter.

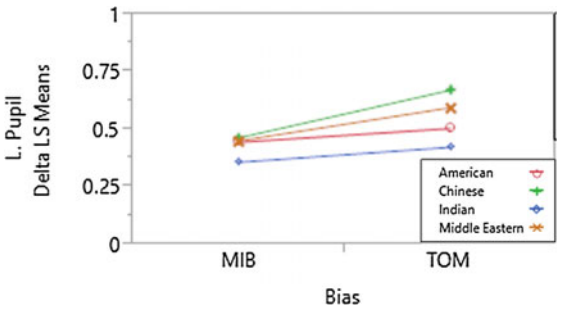

Fig. 2 LS means plot comparing left pupil delta for each culture according to MIB and TOM shows a trend of TOM consistently higher than MIB

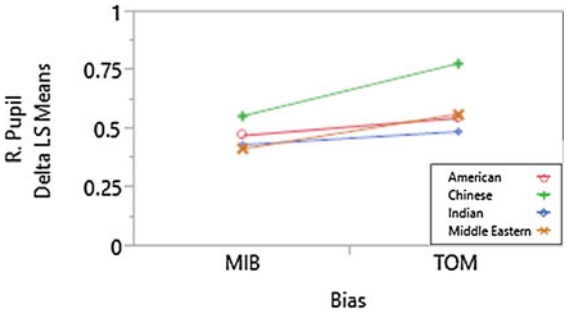

Fig. 3 LS means plot comparing right pupil delta for each culture according to MIB and TOM shows a trend of TOM consistently higher than MIB

5 Discussion

When answering questions about the scenarios, Mirror Imaging Bias occurred more frequently than Theory of Mind. Mirror Imaging Bias is seen as a "shortcut" method as it requires a lower cognitive load. As stated before, the majority of individuals would answer based on their own personal experiences when they were unsure on how to act in a different culture. Others would try to recall knowledge from media such as movies and television shows which have people from that culture. Mirror Imaging Bias occurred almost twice as much as Theory of Mind for all participants.

The analysis for response time showed that there was a significant difference found in the response time when comparing Mirror Imaging Bias and Theory of Mind. For all groups, Theory of Mind exhibited a greater response time than Mirror Imaging Bias by an average of 0.44 s. This supports how individuals take less time responding as they would naturally instead of changing their perspective to match that of the culture present.

When analyzing the change in pupil diameter for both the left and right eye, there was a significant difference between Mirror Imaging Bias and Theory of Mind. When there is a higher cognitive task load involved, the pupils will respond [12, 15]. This supports how Theory of Mind has a high change in pupil dilation than Mirror Image Bias. There was also a significant difference for the average pupil diameter changes between the different cultures. However, all cultures showed that the pupil diameter increased when Theory of Mind was used to answer questions both scenarios.

The number of fixations were found to have a significant difference between Theory of Mind and Mirror Imaging Bias. Overall, the group as a whole showed to have an average of 1.5 more fixations when utilizing Theory of Mind. Throughout the cultural groups, Theory of Mind was consistently higher in number of fixations than Mirror Imaging Bias throughout all cultural groups.

6 Conclusion

These observed metrics reinforce how when Theory of Mind is implemented, a higher cognitive load is present. Individuals must take into account how another individual would interact with a scenario which may be different from how an individual is used to acting. Most people choose to take the shortcut of using Mirror Imaging Bias. By using Mirror Imaging Bias, individuals avoid a higher cognitive load because they interact with the scenarios through their own lens. By using their own personal experiences, they eliminate taking other cultural practices into account as well as any other facts that could help make a conclusion. Since Mirror Imaging Bias naturally happens more often in all of these scenarios, it is important to find a way to ensure that individuals can learn how to implement Theory of Mind in critical situations.

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