1. INTRODUCTION

Theories of EMBODIED COGNITION posit that mental representations are partially formed by simulations of embodied experiences (Barsalou, 1999). The way we experience the world with our bodies influences our conceptualizations. Rather than thinking of mental representations as abstractions that are purely thought-based, this approach suggests that there is a link between the embodied experiences a human has and the mental representations they form. Casasanto (2009) further explored this idea by proposing that people with different kinds of bodies experience the world differently. If cognition is embodied, then these differences would also show up in how people mentally represent information. He termed this the BODY-SPECIFICITY HYPOTHESIS.

One form in which body-specificity manifests is through dominant side bias or HANDEDNESS. Handedness has long been a topic of interest for researchers investigating its potential genetic traces and cultural influences on its presentation in individuals (Marchant et al, 1995, Tang et. al, 2021). Previous studies that investigated the validity of body-specificity hypothesis with handedness (Casasanto 2009, Casasanto & Jasmin 2010) have shown that individuals associate positive valence with their dominant side and negative valence with their non-dominant side. This paper investigates whether practice interferes with these associations. If an individual has engaged in an activity with their non-dominant hand for a long period of time, does that influence their associations between dominant side and valence?

This question gets to the heart of the body-specificity hypothesis. If the way we experience the world is considerably altered through practice, would that also change our associations or does the effect of practice on handedness have a “ceiling” as observed by Marcori et. al (2019)?

The materials focused on sportspersons (specifically, cricketers) as they rely heavily on their dominant side during play. Some players train with their non-dominant hand for different advantages. Brooks et. al (2004) demonstrate that players who play with the left-side as their dominant side are more likely to succeed as batters. Moreover, in their interviews, sportspersons are likely to be more spontaneous than politicians. Politicians are trained orators and might be more conscious of their speech and gesture than people who are engaged in sports. Additionally,

emotions are typically heightening immediately after the match (regardless of the outcome) and the players might be more spontaneous in their responses. This study has three hypotheses.

1) The players might show a bias similar to the one observed by Casasanto wherein they gesture more with their dominant hand for positive things and with their non-dominant hand for negative things.

2) The players might gesture more positive things with their non-dominant hand due to it now being primed after playing and having gained greater skill in operating with that hand over time.

3) An overall "right is good" bias (owing to linguistic and cultural motivations).

2. BACKGROUND

In a laboratory study, Casasanto (2009) tested this hypothesis with the help of five experiments. He focused on "handedness" as the differing factor across participants. A language like English has a strong RIGHT IS GOOD BIAS. Davidson's study (as cited in Casasanto 2009) found that actions with the right side of the body were correlated with POSITIVE VALENCE and actions with the left side of the body were associated with NEGATIVE VALENCE. Although this evidence came from neuropsychological tests, similar associations have been observed in language (e.g. "having two left feet"). Do these associations arise from some innate neurobiological factors or is this an effect of a general lateralization trend in humans? Most humans have a dominant side and only about 10-15% are left-handers (Masud et. al, 2012). Casasanto argues that this majority right-handed bias might have affected our cultural and linguistic understanding of these associations.

The experiments tested the associations between horizontal space (right-left) and valence for individuals who are right- or left-handers. Uniform findings would've hinted at a universal mechanism that influences our association while differing results would have supported the body-specificity hypothesis. Casasanto found that right-handers were more likely to associate right with positive ideas (such as goodness, intelligence, attractiveness) and left with negative ideas while left-handers were more likely to associate left with positive ideas and right with

negative ideas. He concluded that cultural or linguistic experiences cannot predict the GOOD IS LEFT METAPHOR observed for left-handers. Instead focusing on the body-specificity can highlight embodied associations of at least some abstract concepts. However, one of the limitations of the findings were that they came from a controlled environment.

To test its applicability to the real world, Casasanto and Jasmin (2010) conducted another study where they analyzed the 2004 and 2008 US presidential debate speeches. John Kerry (Democrat) and George W. Bush (Republican), the 2004 candidates for president, were both right-handed while Barack Obama (Democrat) and John McCain (Republican), the 2008 candidates for president, were both left-handed. The study aimed to find if speakers tend to gesture more with their dominant hand when talking about positive things and gesture more with their non-dominant hand when talking about negative things. They found that speakers associate positive messages more strongly with dominant hand gestures and negative messages with non-dominant hand gestures, revealing a hidden link between action and emotion. They found no correlation between handedness and the political left-right dichotomy.

Following this line of work, the present work tests how robust these effects are by looking at individuals who regularly engage their non-dominant hand in their profession. Iani et al. (2014) suggest an EFFECT OF PRACTICE on handedness. In their study, they tested Ladavas' (1987) hypothesis that people have a stronger association of dominant hand with upper visual stimuli. Participants were shown squares of different colors and were asked to quickly identify the correct color using a key with either their right (press "L") or left hand (press "D"). Findings from the first experiment supported this hypothesis that participants were faster at responding when the squares in the top half of the screen corresponded with the button on their dominant side. In the second experiment, the participants were first asked to perform a practice-mapping task which emphasized either left-up/right-down or right-up/left-down mapping. When the participants performed the same experiment again, the results were significantly influenced by the practice-mapping condition they were in. They conclude that short term associations acquired during prior practice can override the associations established over time. What does this mean for the body specificity hypothesis? If individuals are involved in an activity which requires them to use their non-dominant hand more often, would it reduce the effects observed in Casasanto's study? One could trace a similarity between the associations UP IS GOOD, RIGHT IS GOOD

correlation between UP and RIGHT for right-handed individuals. How would this play out in the real world?

Lastly, Sandve et. al. (2018) conducted a study to test if handedness can be changed after a short period of practice. They concluded that after 15 days of intensive training, participants gained more skill with their non-dominant hand but their ratings on the handedness test remained unchanged. However, they highlight greater individual variability after the training period. Their finding agrees with Marcori et. al. (2019) who suggested a CEILING EFFECT for handedness plasticity. If this is true, then the practice effect of using the non-dominant hand would not significantly alter the DOMINANT SIDE IS GOOD association individuals might have created. They also observe that the degree of handedness can be reduced by years of lateralized practice with the non-preferred hand in a variety of specialized motor skills. For athletes, practicing the motor skills with the non-preferred body-side leads to less lateralized overall behavior.

To test these, post-match interviews of four cricketers were analyzed. These are all prominent batters who use their non-dominant hand for a significant amount of time. In cricket, a batter choses their stance based on their dominant hand. This is an important factor as it affects the entire field placement by the other team and the directions in which the ball could go. The batter's handedness is also an important predictor of the bowler's success. The players whose interviews are analyzed here have all trained with their non-dominant side for years to gain expertise as a batter. What effect does extended training with the non-dominant side have?

3. METHODS

The post-match interviews were sourced from YouTube. The average length of the interviews was 15 minutes. Two of the players are left-handed but play as RIGHT HAND BATTERS, namely Ajinkya Rahane (India) and Kane Williamson (New Zealand). Two of the players are right-handed but play as LEFT HAND BATTERS, namely Alastair Cook (England) and Smriti Mandhana (India[1]). All of these players play amongst the first four players on the pitch (this ensures their probability of having spent longer time as a batter on the field). All of them have also served as captains of different teams (increasing the chances of them appearing in post-match interviews).

For Cook, two videos were selected to make up the length. The videos fulfilled the following criteria.

1) Post-match interviews after the player had engaged their non-dominant hand.
2) Videos where their gestures are clearly visible.
3) They are not holding the microphone themselves.

Gestures from each interview were numbered and their corresponding linguistic clause was identified. Then each clause was coded with valence: negative, positive, and neutral. Only the clauses with negative and positive valence were included in the analysis. For example.

FIGURE 1. Alastair Cook gesturing with his left hand during a post-match interview.

During this still from the interview, the player was saying *You can't look into the future too much*. This was coded as a statement with negative valence.

All of the interviews were in English. It is important to note that two of the players are multilingual and use English as their second language. This could be a potential limitation as previous research (Pavlenko, 2008) suggests that individuals' expression of emotion differs depending on their language proficiency among other factors. The fact that they were answered questions in their second language might have played a role. There were also cultural differences across the players which were not accounted for, unlike Casasanto's study which focused on US politicians who had more in common culturally. Finally, one of the interviews with Ajinkya

Rahane had a two-minute segment out of the 15 in Marathi. This switch between languages might have also skewed the results a bit.

4. RESULTS

The following table contains the raw counts obtained from the analysis. The top two rows contain data from players who are left-handed and play with their right hand while the bottom two rows contain data from players who are right-handed and play with their left hand.

Players	**Valence**	**Hand gesture**		
		Right	**Left**	**Both**
Ajinkya Rahane	Positive	1	**8**	1
	Negative	4	1	3
Kane Williamson	Positive	3	**4**	0
	Negative	5	4	0
Alastair Cook	Positive	**4**	2	2
	Negative	6	3	6
Smriti Mandhana	Positive	**13**	2	1
	Negative	6	2	2

TABLE 1. Raw counts from the analysis of video interviews.

As is evident from the table, the data collected for this study is not extensive. However, there are some trends. In general, all players gesture more with their NATURALLY DOMINANT HAND while using linguistic clauses with positive valence. Similar effects are not as observable for clauses with negative valence. This effect seems to be stronger for both of the Indian players in this dataset. The following graphs present the trends for each player.

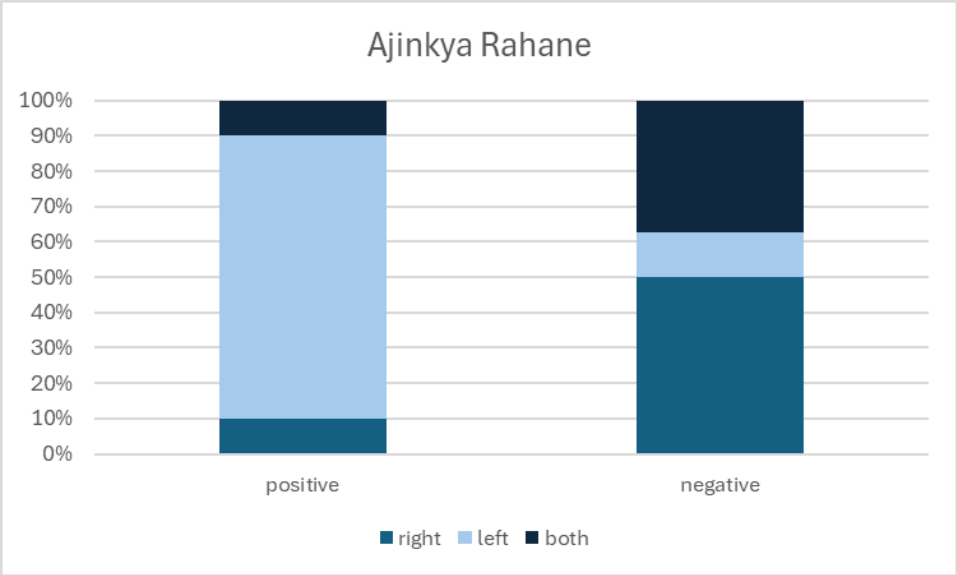

FIGURE 2. Gesturing trends for Ajinkya Rahane who is a left-hander.

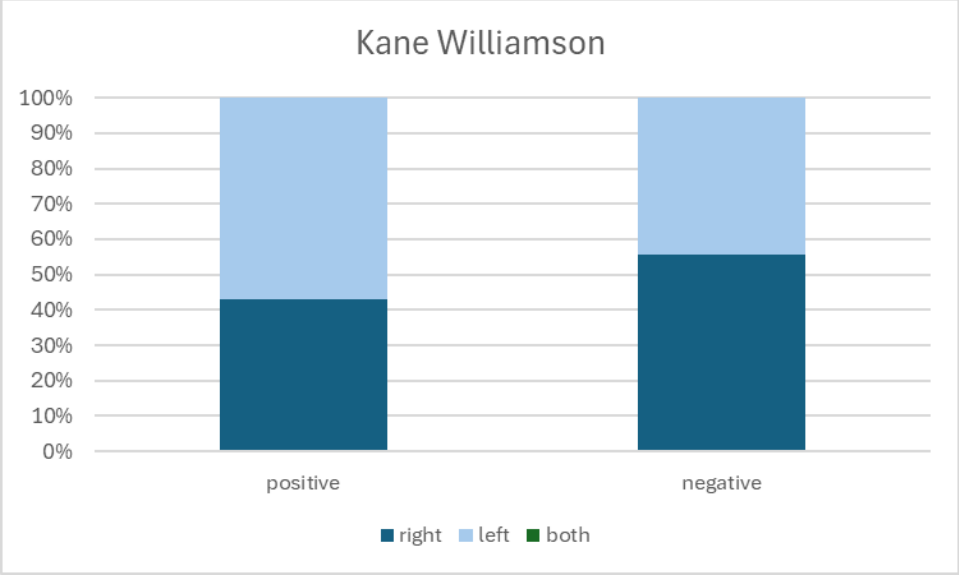

FIGURE 3. Gesturing trends for Kane Williamson who is a left-hander.

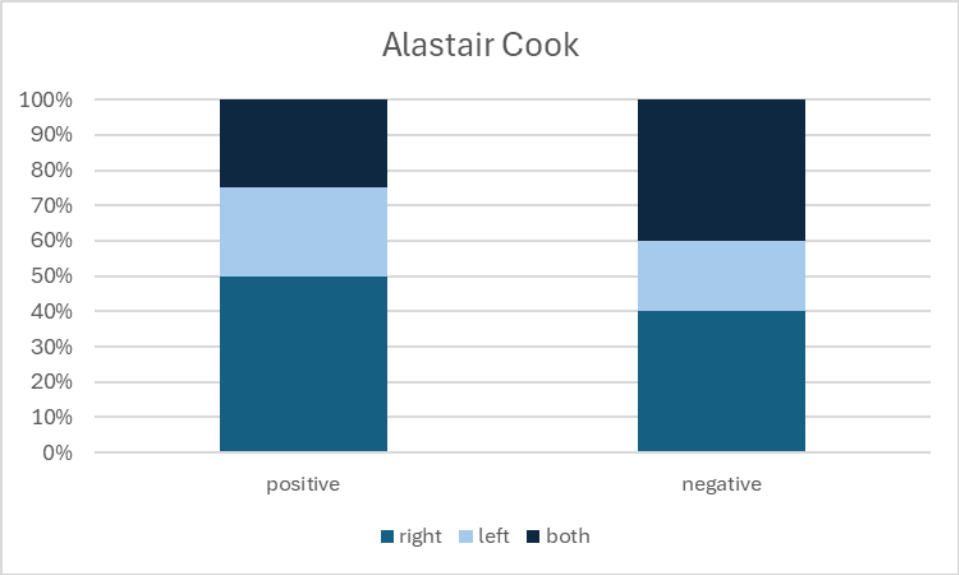

FIGURE 4. Gesturing trends for Alastair Cook who is a right-hander.

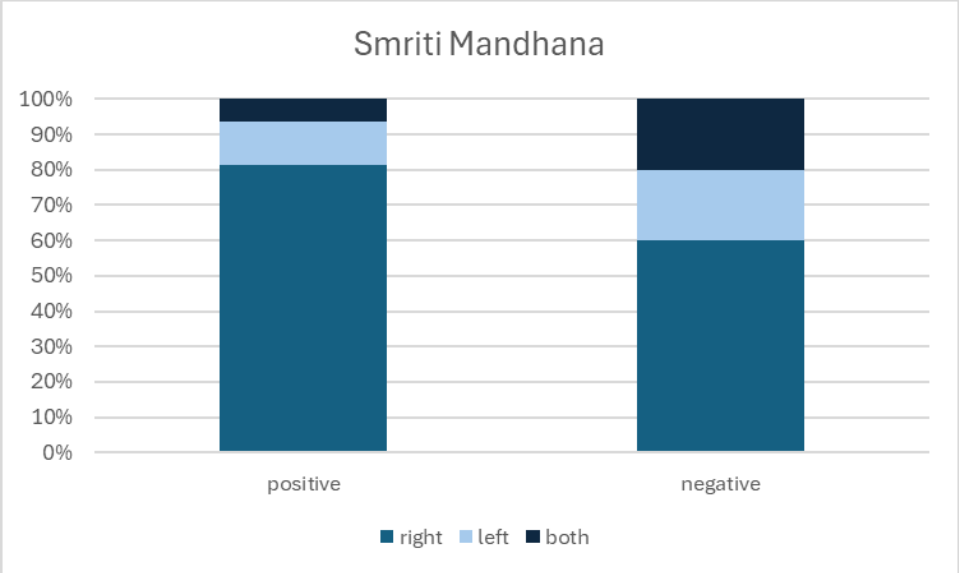

FIGURE 5. Gesturing trends for Smriti Mandhana who is a right-handers.

Fisher exact tests were conducted to test the significance of these trends for each group. For the left-handers, the Fisher exact test statistic value was 0.0634 which is *not* significant. The trend we observe that left handers are more likely to gesture with their left hand while saying positive things might be a random chance.

For right handers, the Fisher exact test statistic was 0.7029 which is *not* significant. Once again, the trends we observe are not statistically significant. The correlation between positive valence and right-hand gestures for right-handers could be due to chance.

5. DISCUSSION AND CONCLUSION

Upon preliminary observations, the left-handers make use of their left hand more often than the right handers do, especially while saying positive things. Alternatively, the right handers gesture more with their right hand while saying negative things. These observations agree with Casasanto's (2009) findings. The natural tendency of the individual to gesture with their DOMINANT HAND is not overridden by practice. However, these findings were not statistically significant. This could be due to number of factors including sampling errors, cultural & linguistic differences, or the small sample size.

If we assume that the results would still be similar with more data, it will point towards some effect of 'practice' on the gestures. It is possible that the playing effect has reduced the association between dominant side and positive valence but not enough to flip it. At the moment, there are huge discrepancies in the number of gestures used by each player. For example, Smriti Mandhana used 23 gestures while Alastair Cook used only 15. Moreover, the stark differences in the gesture behavior for positive versus negative valence clauses is more apparent in the Indian players than the Western players (although both of them are from different countries). It would be helpful to conduct this study with a monocultural dataset to avoid these influences. Furthermore, there could be differences in terms of the number and kinds of gestures used based on the individual's gender performance which would be an important factor to consider.

With the given data, it seems that the findings do not agree with any of the hypothesis proposed earlier. The first hypothesis predicted that Casasanto's findings will be replicated. This hypothesis is the most promising but the statistical test results do not align with it. The second hypothesis posted an opposite effect which is not the case. Finally, the third hypothesis proposed that PRACTICE would neutralize the associations between dominant hand and positive valence in turn leading to an overall RIGHT IS GOOD BIAS due to linguistic and cultural influences.

The findings suggest a fourth possibility which is a combination of Casasanto's and Marcori et al's (2019) proposal. Individuals do have a tendency to associate positive things with their dominant side however this effect can be partially altered due to practice. Since there is a CEILING EFFECT to handedness plasticity, the effect of practice does not completely override the natural dominant side and positive valence association. It is also possible that these individuals are ambidextrous and do not have a strong dominant side like others. These findings do not go against the body specificity hypothesis. If our mental representations are partially influenced by the way we interact with the world, then consistently using the non-dominant hand in a dominant way would have some effect of other associations. These might look different for different people are there is great variability in terms of people's levels of handedness. One important difference between Iani et. al's (2014) experimental study and this one is the tasks the individuals are engaged in. Their second experiment specifically trained the participants with a practice mapping task to either association up with left or right. In the present study, the individuals engage their non-dominant hand in their profession which is different from an experimental setting where participants can be trained with either good is right or good is left mapping. It is possible that the valence associations are more internalized and cannot be completely altered that easily even with years of practice.

6. LIMITATIONS

All ratings were done by the researcher and not verified by others. As a result, the judgements about the valence of the linguistic clause (positive, negative, or neutral) could be biased. It would be helpful to have multiple raters to avoid personal differences and interrater agreement can be used as a reliable metric to ensure objective coding. Although all the sportspeople are engaged in the same sport and play the same position, this study did not account for cultural and linguistic differences. Additionally, unlike the political debates, two sportspeople cannot be expected to be in the same situation and hence the context always varied from video to video. It is possible that the gesturing behavior was influenced by their emotional state which cannot be controlled for.

Gender was not included in the study as a significant factor. This might be a limitation as different cultures have different associations between gender and left-right orientation. As

mentioned earlier, gender performance could have an effect on gesturing behaviors of individuals. This study looked at interviews from three men and one woman. Finally, handedness information was sourced from the internet, and the extent to which each player considers one to be their dominant hand is unknown. In other studies (such as Iani et al., 2014), the participants were administered standardized dominance test which presented the researchers with a well-rounded understanding of the participants' handedness.

7. NOTES

[1] While there is much attention given to handedness bias in India, the specific way in which it manifests is not very different from the West. The RIGHT IS GOOD BIAS holds for all the selected individuals in this study and giving special attention to handedness bias in India as opposed to the West only perpetuates orientalist "Other" notions (cf. Mandal & Dutta., 2001). Furthermore, the cultural impact was counterbalanced across the two conditions owing to the choice of the specific cricketers.

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