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# TYPES OF CHILD MIRRORING BEHAVIOR

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## Abstract

In this paper, we build upon previous research that examined adaptive behaviour in communication and present a study of co-occurring and mirroring gestures in first encounters. This research was conducted in order to better understand how people adapt their communication styles when they meet new people. In addition, we present experiments using machine learning in which classifiers are trained on knowledge about the gestures of one participant in order to anticipate the behaviour of the interlocutor. These experiments are an extension of earlier work that focused on facial expressions Our primary hypothesis is that mirroring effects occur frequently in face-to-face communication and that these effects involve all types of gestures. Additionally, we hypothesise that mirroring should and can be accounted for in advanced and cognitively aware information and communication technologies. The following outline should be used for the paper. Following that, in part 2, we discuss similar research, and in section 3, we talk about the corpus itself as well as the annotations. The part titled "Section 4" covers the description of the extraction of mirroring gestures as well as the presentation of the analysis of mirroring gestures. In the next part, number 5, machine learning experiments were conducted with the purpose of determining whether or not information about the gestures created by one subject may be used to anticipate the presence and kind of gestures made by the interlocutor. In the next part, "Section 6," we will describe the outcomes of the tests, and in the following section, "Section 7," we will draw a conclusion and provide some recommendations for further research.

**Keyword:** communication styles, mirroring gestures, primary hypothesis

## ,Introduction

According to the findings of several studies, establishing and maintaining a positive rapport between teachers and students in the context of educational communication is a key component of efficient teaching and successful learning (Frisby & Martin, 2010; Murray, 1997; Wittler & Hill, 2004). Rapport is a personal experience that is the result of a collection of sensations that arise from the interaction and varies throughout the duration of the engagement. Rapport is something that develops in the course of interaction and refers to a personal experience. According to the theory put forward by Tickle-Degnen and Rosenthal (1990), there are three fundamental elements that make up rapport: (1) mutual attention; (2) positivity; and (3) interpersonal coordination. Participants demonstrating interest in and focusing on the interaction to establish a cohesive and unified community is an example of mutual attention. Participants experience positivity when they sense the friendliness and warmth of others and demonstrate mutual regard and care for one another. Participants are said to be engaging in interpersonal coordination when they are able to foresee and react in a spontaneous and active manner, as well as experience harmony and synchronicity throughout the engagement. Research has shown that nonverbal behaviour plays an important part in establishing rapport between teachers and students (Babad, Bernieri, & Rosenthal, 1991; Benson, Cohen, & Buskist, 2005; Darrow & Johnson, 2009; Harrigan, Thomas, & Rosenthal, 1985), but teachers are still unsure of how to use nonverbal behaviour appropriately in their interactions with students.

A trip on a train may be considered the most routine activity. We start our day by taking a seat early in the morning, just across from a person who seems to be exhausted. The yawns of other passengers are infectious, and as we fight the want to yawn ourselves, we say to ourselves, "Well, I can feel you." We have the ability to put ourselves in the shoes of others even when language is removed from the equation. By doing so, we are able to grasp their state of mind, their emotions, as well as their objectives and the meanings of the behaviours that they do. It all seems inconsequential and completely par for the course. Nevertheless, as humans, we are distinguished from other individuals by our exceptional capacities for social interaction, which accounts for our status as a social species (Tomasello, Carpenter, Call, Behne, & Moll, 2005). Therefore, competencies such as non-verbal communication (Knapp & Daly, 2011), gaze behaviour (Brooks & Meltzoff, 2015), or imitation (Marshall & Meltzoff, 2014a) are vital for the comprehension of others, learning processes, and for navigating through complicated social circumstances.


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## LITERATURE REVIEW

Amanda L Woodward (2014) The finding of mirror neurons in the motor cortex of monkeys has given rise to a broad range of speculations about the possible connections that might be made between movement control and social cognition. In this article, we examine the idea that the connection in question contributes to the early development of an essential component of social comprehension, namely the capacity to interpret the acts of others in terms of their own intentions. Recent research on baby action understanding has shown a deep network of linkages between the development of motor skills and the evaluation of intentions behind the acts of others. Infants' own goal-directed activities, in particular, impact their interpretation of the aims of other people. According to this body of data, the cognitive mechanisms that are responsible for driving babies' own activities also contribute to their understanding of the intentions behind the acts of others. These effects take place at a rather abstract level of analysis, both in terms of the structure newborns perceive in the acts of others and in terms of the structure that is important to infants' own activities. Evidence suggests that the connections between action production and action perception in infancy involve the interrelated neural systems that are at work in generating planful, intelligent action. Although the neural bases of these effects in infants are not yet well understood, current evidence suggests that these connections exist.

Costanza Navarretta (2019) Not only is the ability to mirror and synchronise one's own non-verbal behaviour a vital aspect of human behaviour, but it also plays a significant role in communication. This study's objectives are to (1) examine the occurrences of mirroring gestures in first encounters, which include head movements, facial expressions, body postures, and hand gestures; (2) determine whether information about the gestures of an individual can be used to predict the presence and the class of the gestures of the interlocutor; and (3) determine whether information about an individual's gestures can be used to predict the presence and the class of the gestures of the interlocutor. In addition to that, the contribution of associated speech tokens is looked into. The examination of the interactions reveals that 20–30% of the body postures, facial expressions, and head movements are reflected in the corpus. On the other hand, there are very few instances of mirrored hand gestures. Because of this, they were excluded from the trials that predicted the future. The findings of the experiments, which made use of a variety of machine learning algorithms, indicate that information about the shape and duration of the gestures performed by one


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participant contributes to the prediction of the presence and class of the gestures performed by the other participant, and that adding information about the related speech tokens improves the prediction performance in some instances. The experiments were conducted with two people, each of whom performed a series of hand gestures while the other participant watched them. Based on these findings, it seems that it would be beneficial to build and put into practise cognitively aware info-communicative systems that take into consideration mirroring.

Zhou Jiang-yuan (2012) The purpose of this research was to evaluate the impact that nonverbal mirroring has on the rapport that develops between a teacher and a student during one-on-one conversations. In the context of social interactions, the term "nonverbal mirroring" refers to the unconscious imitation of the postures, mannerisms, facial expressions, and other behaviours of one's interaction partner by the mirrored party. Students participated in a paradigm with within-subjects conditions, in which they had four encounters with a teacher under two situations: one condition was coupled with the instructor's mirroring behaviours, while the other condition was matched with the teacher's non-mirroring behaviours. Students' self-rating surveys and analyses of the teacher's mirroring behaviours in interactions showed a substantial rise in the students' assessment of rapport in the mirroring condition. There was a strong correlation between rapport characteristics and four different nonverbal mirroring behaviours. The findings suggest that instructors may use nonverbal mirroring as an effective teaching strategy to create rapport with their students and present some practical implications for doing so.

## RESEARCH MATHALOGY

### 3.1 INTRODUCTION

To test the hypotheses presented in chapter 5.4., the experiment was conducted with two different populations, first with a group of controls, and second with a group of persons diagnosed with ASD. Results of this event-related study, consisting of two conditions, were compared between the groups. A new, homogenous stimulus set was created and utilized to measure the detection rates for actions and moods with as few likely confounding variables as possible. Sample and material, including two questionnaires, will be explained more accurately hereinafter. The operationalization of the target figures mirroring and mentalizing


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will be explained. Finally, the procedure, data processing and statistical analysis will be described.

## 3.2 PARTICIPANTS

For the purpose of conducting this behavioural research, volunteers for the control group were gathered via the use of mailing lists and word of mouth. All of the participants in the autistic group had been given a diagnosis of HFA at the outpatient clinic for adults with autism that is part of the university clinic in Cologne. These individuals were found via the use of mailing list databases. Both sets of participants were excluded if they met the criteria of having comorbid neurological and mental illnesses, were currently taking psychotropic medication, or were actively suicidal. In order to qualify for the study, participants needed to be between the ages of 18 and 60 and have normal or corrected visual acuity. Everyone who took part in the experiment had no idea what the point of it was. All of the people who were going to take part in the study submitted their verbal and written informed permission prior to the beginning of the experiment, as required by the ethics committee of the University of Cologne and the declaration of Helsinki (World Medical Association, 2013). The final group consisted of 28 control participants (15 females, mean age = 34.54, SD = 10.94) and 25 volunteers who were diagnosed with autism (nine of them were female, mean age = 41.32, standard deviation = 9.85). Table 3. 1 provides more example information for your perusal.

**Table 3. 1 Participants Demographic And Questionnaire Data**

| Variables | Controls | | | | Persons with Autism | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SD* | | *n* | *M* | *SD* | *t* | *p* | *df* |
| Gender | | | | | | | | | | |
| Female | 15 | | | | 9 | | | | | |
| Male | 13 | | | | 16 | | | | | |
| Handedness | | | | | | | | | | |
| Right | 25 | | | | 23 | | | | | |


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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Left | 3 | | | | 2 | | | | | |
| Age | 28 | 41.32 | 9.86 | | 25 | 34.54 | 10.04 | 2.32 | .022** | 51 |
| Education alYears | 25 | 18.18 | 5.6 | | 24 | 17.7 | 3.98 | .337 | .737 | 47 |
| AQ | 27 | 22.11 | 6.19 | | 25 | 39.08 | 5.27 | 10.61 | <.001*** | 50 |
| EQ | 26 | 43.88 | 9.87 | | 25 | 15.6 | 8.58 | -10.9 | <.001*** | 49 |

*Note*. *n* = number of subjects; *M* = mean; *SD* = standard deviation; *t* = t distribution; *p* = probability; *df* = degrees of freedom; AQ = Autism-Spectrum Quotient (Baron-Cohen, Wheelwright, Skinner, et al., 2001); EQ = Empathy Quotient (Baron-Cohen & Wheelwright, 2004); * *p* < *.05; ** p <.01; ***

*p <.001.*

## DATA ANALEYSIS

### 4.1 INTRODUCTION

This research included a total of 42 people: 28 healthy volunteers and 25 individuals diagnosed with autism. The age gap between the two groups was large enough to be statistically significant, with t(51) = 2.316 and p =.022 respectively. Upon closer inspection of the data, it was discovered that the set of controls had two anomalies. Within the context of the condition that investigated subjects' ability to recognise actions, one participant's mean accuracy was more than two standard deviations apart from the mean. During the phase of the experiment that focused on the subject's ability to identify moods, another participant's mean accuracy was more than two standard deviations apart from the mean. The arguments in favour of retaining certain topics and against eliminating them were given considerable consideration and weighed against one another. It's possible that the people in question were too weary, absentminded, or just lacked a sufficient understanding of the assignment. Because this research was the first of its kind to use the novel stimulus set in an event-related context to analyse the performance of two separate groups, there was no previous data with which to compare the findings of the study. As a result, no information regarding the way


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data is distributed has been obtained up until that point. It was agreed to save the data of both participants for the purpose of doing further research. This allowed for a comprehensive analysis of the dataset to be carried out. A second study revealed that the findings did not change from the first analysis when those outliers were removed.

Linear regressions were computed in order to explore whether or not age and gender had a role in the outcome. Age was not included in any of the subsequent analyses since the detection rates for neither movements nor mood were substantially connected with age (all r's were less than 0.01, all p's were less than.48). There was also no correlation between gender and the rate of detection (all t's were less than 0.111, and all p's were less than.912) Also, when each group was investigated on its own, there were no age or gender relationships observed that could be established. Additional statistical analysis was carried out with the use of generic linear mixed effects models and the glmer() programme. To serve as a foundation for future work, a null model was developed. The first version of the model, which was also the simplest, consisted just of the several conditions ("Rule") as fixed effects. The second model also included the diagnostic group ("Group") as an extra component. An investigation into the dynamic relationship between Rule and Group was included into the third and final model. The models will be presented in the next section in the form of functions (Bates et al., 2014; Wollschlager, 2015). The dependent variables are shown on the left, while the independent variables, known as regressors, are shown on the right of the tilde (). The symbol "+" indicates that the impact is additive. A "*" denotes an effect that interacts with another. The parenthesis indicate the presence of random effects, while the pipe symbol (|) serves as the grouping factor. In the first model, known as the null model, the only variable that is taken into account is the subject themselves, who acts as a random effect.

Model 0: Detection rate ~ + 1 + (1|Subject)

Model 1: Detection rate ~ Rule + (1|Subject)

Model 2: Detection rate ~ Rule + Group + (1|Subject)

Model 3: Detection rate ~ Rule * Group + (1|Subject)

Table 2 presents a mapping of an analysis of deviation that was performed by comparing all four models. According to the results of the AIC and BIC calculations, the model that


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included rule and group as fixed effects was deemed to be the most appropriate model to use when attempting to explain the dataset. The fit of the model was not substantially improved by the addition of the interaction between the rule and the group as a predictor. The interaction does fit better, as shown by the value for deviance; nevertheless, this improvement is not statistically significant, and both AIC and BIC suggest that the less complicated model 2, which fits the data best, is the best option. Significant main effects may be discovered at both the rule and the group levels of analysis.

The chances of providing the right response on the action identification test were 1.36 times higher than the chances of providing the correct response on the mood detection task (standard error of the mean = 0.08, X2 (1) = 16.72, p .001). It was found that the chances for a correct detection in the group of controls were 1.53 times the odds of a right response in the group of individuals with autism (standard error of the mean = 0.14, X2 (1) = 9.01, p =.003). This was found for the group that was considered to be a fixed factor. According to Chen, Cohen, and Chen's (2010) findings, this equates to a moderately modest impact for the rule, and a moderately small to medium effect for the group. Boxplots illustrating the detection rates of participants in accordance with diagnostic group and rule are shown in Figure 3, which serves to highlight the results. The detection rates were determined for each individual participant and then segmented according to the conditions. This was done by comparing the number of successfully completed trials to the overall number of trials in a given condition.

**General Linear Mixed Effects Models**

| | *Df* | AIC | BIC | *logLik* | *deviance* | *Chisq* | *Chi Df* | *Sig.* |
|---|---|---|---|---|---|---|---|---|
| Null-model | 2 | 4148.1 | 4260.3 | -2072.1 | 4144.1 | | | |
| Rule | 3 | 4133.4 | 4151.8 | -2063.7 | 4127.4 | 16.72 | 1 | <.001*** |
| Rule + Group | 4 | 4126.4 | 4150.9 | -2059.2 | 4118.4 | 9.01 | 1 | .003** |
| Rule * Group | 5 | 4127.6 | 4158.3 | -2058.8 | 4117.6 | 0.74 | 1 | .390 |
| *Note. * p < .05; ** p <.01; *** p <.001.* | | | | | | | | |


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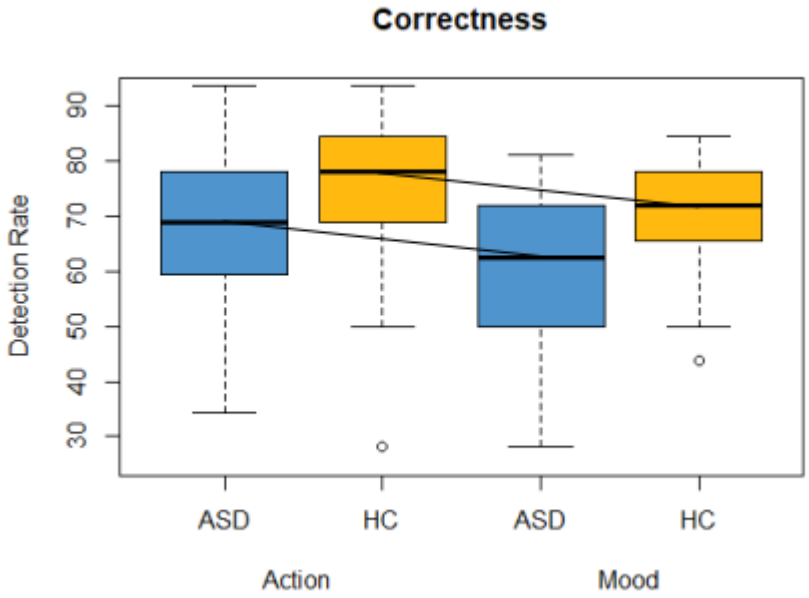


**Boxplot Displaying Detection Rate As A Function Of Group In Mood And Action Recognition Condition. Detection Rates Were Aggregated For The Individual Subjects And Transferred To Percentage Values. Medians Of Detection Rates Are Marked By Thick Black Lines. Medians Of Both Conditions In One Group Are Connected.**

A visible difference can be seen between groups, especially in mood recognition. Within the groups a difference can be seen between the two different rules that are stated. The t-test analysis will be described in the following for the purpose of making the findings and their relationship to the previously stated hypotheses more easily understood. Post hoc t-tests allow for the observation of the same outcomes. A paired sample t-test was used to investigate the first hypothesis, which postulated the possibility of a significant difference between mood recognition and action recognition in people with autism when both types of recognition are addressed with the same visual input. According to the findings, people with autism do noticeably better when it comes to identifying actions as opposed to identifying moods ($t(24) = 2.514$, $p = .019$). It was shown that there was no difference in the detection performance of mood and action recognition in the controls ($t(27) = 1.399$, $p = .173$), which was consistent with the predictions of hypotheses 2.

The third hypothesis claimed that when the two diagnostic groups were compared, people with autism and controls differed in their capacity to perceive emotions, with controls having a higher performance overall. This was based on a comparison of the two groups. Regarding


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the identification of emotional states, a distinction was found (t(51) = -3.028, p =.004). In the action detection task, those with autism did just as well as HC, as hypothesis 4 predicted they would. There was not a discernible change that could be considered statistically significant (t(51) = -.858, p =.069). In overall, there was found to be a significant difference between the two alternative rules, which addressed mood and action recognition abilities (t(52) = 2.719, p =.009). The fifth through the eighth hypotheses looked at the associations between the scores on the AQ and EQ and how well participants did in the research. Both the correlation between AQ and the accuracy of action detection (t=-3.107, p=.003) and the correlation between AQ and the accuracy of mood detection (t=-2.824, p=.007) were shown to have statistically significant findings when computed using linear regression. According to the information presented here, it seems that a higher score on this questionnaire is associated with a lower recognition rate of action and mood, respectively. However, when the data were analysed according to the different diagnostic groupings, there was no association to be detected (all r's were less than 0.057, and all p's were less than.261). There was not found to be any correlation between the score on the EQ and the recognition performance for action or mood (all r's were less than 0.133, and all p's were less than.227). When looking at the data, it also became clear that many studies still had unsolved questions, particularly in the group of people with autism. In this group, the average number of unanswered trials for action recognition was 4.87 percent, while for mood recognition it was 10.75 percent. The controls had an average error rate of 1,34% in the condition for action recognition and 1,45% in mood recognition. These "misses" were, as a result, also subjected to a more in-depth investigation. These missed opportunities are shown in figure 3, which should make it much simpler to comprehend them. Once again, generic linear mixed effect models were generated in the same manner as was discussed before. This time, trials that did not have an answer were not classified as having a false response; rather, they were classified as having a missing value. The detection rate was thus different from the first investigation. The findings from the study of the deviation are shown in Table 3.


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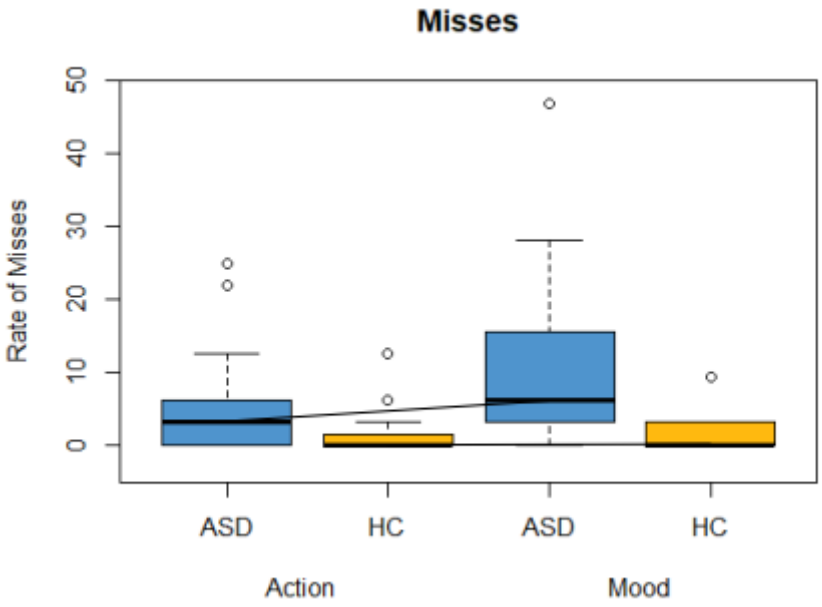


**Figure 4. 1 Boxplot Displaying Unanswered Trials (Misses) As A Function Of Group In Mood And Action Recognition Condition. Detection Rates Were Aggregated For The Individual Subjects. Medians Of Detection Rates Are Marked By Thick Black Lines Which Are Connected For Both Conditions In One Group. Especially In Mood Recognition In Autism A Higher Rate Of Misses Was Observed.**

When all of the models are compared using an analysis of deviation without factoring in any

## CONCLUSION

In this experiment, we deviated from the mirroring hypothesis, which states that a certain number of neurons in the human brain become active not only when a person performs an activity, but also when they see another person doing the same action. Researchers have proposed that mirroring is an essential component in the development of social skills, such as the capability of recognising the intention and goals of other individuals and demonstrating empathy, and that it is also an essential component in the process of learning language and gestures [22, 25, 23, 12]. Mirroring in communication may have a number of impacts, one of which is the synchronisation of verbal and non-verbal behaviour between the people involved in the discussion, as well as the mirroring of gestures. In this study, we have expanded prior research on co-occurring gestures and their influence on the prediction of the gestures which are created in face-to-face discussions. This work was carried out by the authors of the aforementioned research. The examination of the data revealed that head movements, facial


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expressions, and body postures are often in sync with one another. On the other hand, hand motions are not common in these data, and when they do occur, they are seldom replicated. Because of these factors, we chose not to use hand gestures in the trials involving prediction. We trained classifiers on features describing the shape and duration of gestures as well as the speech tokens that were semantically related to them. This allowed us to predict, based on the gestures produced by one participant in the Danish first encounters, the presence of gestures produced by the other participant as well as the subclass of those gestures produced by the other participant. Experiments using machine learning were conducted on body postures in addition to facial expressions and head motions, as was done in earlier research. Moreover, in the experiments that intended to forecast the existence of a gesture by one person based on the gestures by the other participant, we evaluated a variety of algorithms and training/testing methodologies. We also investigated the impact of penalising the prediction of the frequent non-gesture class. The findings of the experiments on prediction show that having information about a participant's gesture improves the ability to predict the presence and class of gestures produced by the interlocutor, in comparison to the majority baseline, which always predicts that the interlocutor will not produce a gesture. This baseline takes into account the vast bulk of the available data. In most circumstances, the prediction is improved by using speech markers that are pertinent to the gesture and were said by the gesturer. The results of the Naive Bayes algorithm that works the best may be greatly improved by penalising the prediction of the frequent non-gesture class corresponding to the greater prior value of that class. When it comes to modelling gestures in communication, there are a lot more aspects that need to be taken into consideration, despite the fact that the results that we have received from the initial meetings are encouraging. In addition, the scope of our study has been limited to a single language and kind of data. Because of this, our findings need to be validated using a wider variety of data formats and language combinations. In the future, we want to study individual variations in mirroring, in addition to expanding the scope of our research to include more corpora. Our research has also shown that certain kinds of gestures are reflected more often than others. As a result, it is important to study if it would be more effective to forecast them separately and extend the weighting technique to the prediction of the subclass of the mirrored gestures.

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