THE ROLE OF INTERPERSONAL SYNCHRONY IN NATURAL COMMUNICATION

by

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Abstract

When speaking to one another, what is unconsciously occurring that leads to mutual understanding, empathy, memory, and language comprehension? We researched the role of interpersonal synchrony and brain synchrony during communication and analyzed data from a previous study in which participants listened to storytellers producing unrehearsed, happy and sad stories. ERP and skin conductance levels were measured from the speakers while they told their stories as well as from the listeners who then listened to recordings of the stories. After hearing each story, listeners looked at sequences of faces morphing from sad to happy and happy to sad. Listeners were asked to indicate when they noticed a change in emotion on the faces. Participants used the Brief Mood Inventory to rate their current mood and used the Multi-Dimensional Emotional Empathy Scale to indicate empathy after hearing the stories. They also wrote down each story heard from the best of their memory. We found that there was a positive correlation between degree of synchrony, empathy scores, and memory scores for the happy story task, as well as a positive correlation between synchrony and empathy scores and a negative correlation between synchrony and memory scores for the sad story task. The findings from this research further our understanding of brain synchrony between a speaker and listener and its effects on mood, empathy, and memory encoding.

Without realizing it, we often copy the gestures, postures, and facial expressions of the people around us. For example, if one person leans in conspiratorially during a conversation, you may instinctually lean in yourself. Why might this be, and how might we predict this kind of gesture mimicry happening? What consequences might these behaviors have for our cognition?

The “Chameleon Effect” describes nonconscious mimicry between people, which occurs when people are engaged in communication (Wilson and Knoblich 2005). This effect has been demonstrated in several studies which were foundational to Wilson and Knoblich’s work. A 2000 study by Brass et al. found that people were quicker to perform a finger movement if prompted by a visual of someone performing the movement, rather than being prompted by an arbitrary cue. Seeing another person perform the movement was more impactful than hearing a cue to perform it. The ease in imitation response may be explained as a faster version of stimulus-response compatibility, meaning that the response is quicker when it is related to the stimulus (Greenwald 1973). This is a nonconscious effect, which demonstrates people’s inherent ability to connect with each other socially. There are many possible causes for this imitation including observational learning, interpersonal bonding, and understanding each other (Wilson and Knoblich 2005).

A study by Paxton and Dale (2013) examines how dyadic pairs establish interpersonal synchrony, or demonstrable synchronicity between two people, while speaking to each other. The researchers assigned dyads to have two conversations on specific topics. These topics were affiliative and argumentative, meaning for one conversation they both agreed on the topic (affiliative) and on the other they did not agree on their topic (argumentative). Video of the participants was looked at with frame differencing analysis, which allowed the researchers to subtract each frame pixel-by-pixel from their neighboring frames and zero out all information that stayed constant across frames. They were able to distinguish when participants' bodies were most active at specific points in conversation. Mimicry, or interpersonal synchrony, could be detected objectively using this technique by measuring the degree of correlation in movement of different parts of the body between conversation partners. Paxton and Dale found that participants mimicked each other less during argumentative conversation. Only dyads participating in affiliative conversation achieved significant levels of interpersonal synchrony. What does this imply? When people agree with each other in conversation and comprehend each other well, they become synchronized in their physical movements. Therefore, agreement and affiliation lead to greater interpersonal synchrony. One theory as to why people do this is because simulating another person's behavior through one's own motor system provides a means for making predictions about what the other person is feeling or what they will do next. Therefore, synchrony provides an unconscious way to bond with one another, focus on the conversation better, and understand one another on a deeper level. Paxton and Dale found that when people show higher levels of behavioral synchrony, they usually empathize with each other and agree on the conversation topic.

People's overt behavior becomes synchronized over time in interpersonal communication, at least when discussing a topic they agree on. Presumably the brain is responsible for producing this behavioral synchrony. Does this mean that people's brain activity becomes more and more correlated during natural communication? Physiological synchrony can be described as a similarity between physiological signals between more than one person. It can be portrayed by brain imaging and expressed in physical movement like gestures and facial expressions. When brain activity is synchronized, people comprehend each other better and often develop similar emotions while communicating. (Hove 2008). According to Hove, interpersonal brain synchrony can potentially increase interpersonal empathy. Empathy is the ability to understand one another's emotions and to imagine ourselves in one's situation. When brain activity is synchronized people form stronger connections and deeper understandings of each other. Hove suggests that mirroring one's actions is a subconscious act when interpersonal synchrony occurs, and therefore the brain does not make clear when one is mimicking. Dancers and musicians who perform in synchrony feel great empathy and affiliation for one another (Hove 2008). Interpersonal synchrony and mimicry leads to high levels of interpersonal empathy, especially when this occurs subconsciously and one is not aware of mimicry.

It is possible for brain activity to become synchronized between a speaker and a listener when they are in separate rooms, at separate times. Brain activity was recorded of a speaker telling an unrehearsed story from their childhood and a listener hearing a recording of the story (Hasson et. al 2010). Significant speaker listener coupling was found in Wernicke's Area and Broca's Area, which are associated with language comprehension. The more in sync the listener and speaker's brain activity was at the same point in the story, the better the listener understood the story. In some cases, the listener's brain activity actually preceded the speaker's, which led to the highest comprehension scores. This suggests that being able to predict what someone will say demonstrates a clear understanding of the communication as captured by this anticipatory pattern of brain synchronization.

Research has made a connection between eye contact and attention as well as lip reading and hearing, even in non-hearing-impaired individuals (Henning et. al). Facial cues from a speaker can increase language prediction and language comprehension in the listener (Dikker et. al). However, synchrony is possible even when people are in some way communicating without seeing each other (Hasson et. al 2010). This present research further investigates listener comprehension in the case of the listener not seeing the speaker.

EEG is sometimes opted to use in research instead of fMRI, because fMRI allows for detailed localization of neural synchrony, but has the disadvantage of poor temporal resolution. EEG is able to investigate in detail the timing of interpersonal coordination and does so unobtrusively (Kuhlen et. al 2012). It has been used in research to look at brain synchronization between activity or communication that dyads are a part of. Kuhlen et. al's (2012) research includes the use of EEG in recording brain activity of speakers and listeners. Each speaker told five stories, four of which were fairy tales provided by the researchers and one was their own account of their favorite book or movie. The speakers directed their storytelling to a camera while wearing the EEG cap. Video and audio recording from two separate speakers were superimposed. Two listeners were assigned to listen to one of the speakers in the combined video and audio, which included two separate stories. The listeners also wore an EEG cap. The researchers found that listeners were able to listen to their assigned speaker, and their EEG was more strongly correlated with the attended speaker than unattended speaker. These findings coincide with brain coupling, as psychological synchrony is correlated with the communicated information. EEG can be used to look into many themes and abnormalities in the brain. This research demonstrates how it can be used to record brain activity of people speaking, which is relevant because often the scan is performed while people are directed not to speak.

According to Nummenma et al., (2012) physiological synchrony can occur when people listen to and view the same auditory and visual stimuli. Similar patterns of neurons fire at the time when people experience the same auditory and visual stimuli. Nummenma et al. tested whether emotions effected by events in movies correlate to brain synchrony between viewers.

Participants watched movies while their brain activity was measured by fMRI. Then each participant once again viewed the movies and rated their experiences from pleasantness–unpleasantness and calmness–activation. These researchers found that brain activity was time-locked across participants in several brain regions, while they viewed the movies. This implies that brain synchrony can occur in people who are sharing an experience.

One possible mechanism for interpersonal synchrony is “mirror neurons” in the brain. The brain fires the same mirror neurons when people perform an action as well as when people observe others performing the same action (Rizzolatti and Arbib 1998).

Previous work in Professor Toskos’ laboratory tested whether physiological synchrony can be measured in course electrical signals emanating from the brain as well as arousal signals detected from the skin. Previous work used fMRI and multi-electrode EEG techniques to measure physiological synchrony, but previous work has not examined whether synchrony can be captured in higher-level physiological states, which should be correlated with those lower-level physiological signals from previous work. The project examined whether physiological synchrony in event-related potentials (ERPs) and electrodermal activity (EDA) predicted how much people were emotionally impacted by and remembered the language they heard. To test this, a set of speakers told happy and sad stories while ERPs and EDA were measured continuously. A separate set of listeners listened to the stories while the same physiological measurements were made. The researchers then measured (1) how much the listeners’ mood was affected on an implicit measure, (2), how much the listeners’ mood was affected on an explicit measure, (3) how well the listeners remembered the stories they heard, and (4) the listeners’ empathy levels were measured. To continue this research, I will be analyzing unexamined data on people's memory for the stories they heard from their original dataset and examining the factors that influence story memory.

I predict that the degree of synchrony between speaker and listener for both the ERP and EDA measures will correlate positively with empathy scores and memory scores for happy stories. For sad stories, I predict that the opposite will be true when it comes to story memory. Listeners should show high levels of empathy after listening to a sad story, with poorer memory scores. When one is empathetic towards a sad situation, they become distressed and this can lead to poor memory encoding (Batson et. al 1984). I predict that story memory will correlate positively with explicit and implicit mood for happy stories, and negatively for explicit and implicit mood for sad stories. Mood is correlated with story memory, in that a happy mood will correlate with better memory, and a sad mood will correlate with poorer memory.

Methods used in original data collection

Participants

Twenty one participants from the Purchase College community were recruited for this study (5 storytellers and 16 listeners). Participants were compensated with course credit (30 minutes of participation was compensated with one course credit) or pay (one hour of participation was compensated with five dollars).

Materials

Auditory Stimuli - Listeners were provided with five sad stories and five funny or happy stories. They were pre-recorded, personal unrehearsed stories and approximately one to two minutes long.

Explicit Mood Measure - Listeners responded to a question from the Brief Mood Inventory, which asked them to rate their current mood. The scale ranged from -10 (very unpleasant) to +10 (very pleasant).

Implicit Mood Measure - A face database was used to gather twenty different series of 15 faces ranging from happy to sad. There were some faces displaying ambiguous emotions in the set. Unambiguous happy and sad faces of the same person were chosen for the two end points of the sequence. The emotions of the faces in a particular sequence might start out unambiguously happy, and then become less and less happy until they pass through a neutral point and start becoming increasingly sad.

Empathy Scale - Listeners responded to the Multi-Dimensional Emotional Empathy Scale. It included 30 statements, such as: “when I'm with other people who are laughing I join in”. Each item used a scale ranging from 1 - 5, 1 being ‘strongly disagree’ and 5 being ‘strongly agree’.

Physiological measurement - A Biopac physiological recording device was used to measure ERP signals from a single point on the forehead, above the left eye, with negative and ground electrodes on the two earlobes. Skin conductance signals were measured from the index and middle fingers of the non-dominant hand.

Procedure

Storytelling Task - Five skilled storytellers were recruited to tell two stories to the participants acting as listeners. The stories were personal and unrehearsed, lasting about one to two minutes. Each speaker told a happy story and a sad story in random order, resulting in 10 total stories. The stories were audio recorded and ERP and skin conductance levels were recorded in each speaker as they told their stories.

Listening Task - 30 participants listened to the 10 pre recorded stories in a random order. Participants were advised to listen carefully to the stories since they might later answer questions relating to them. ERP and EDA measurements were recorded in the listeners while they listened to the stories.

Sequences of faces morphed from happy to sad, and sad to happy. These faces were provided for the listeners to see one at a time after each story. Participants pressed the space bar when they first detected a change in the emotional expression in the face (e.g., a switch from sad to happy). It was predicted that the more people were emotionally affected by the story that they heard, the more readily they would perceive that type of emotion in the ambiguous faces in the series. This served as an implicit measure of participants' mood after hearing each story. Then participants used the Brief Mood Inventory to rate their current mood in an explicit way.

After listening to all of the stories, listeners were asked to write down each story to the best of their ability, to measure story comprehension. Listeners then completed the empathy task, using the Multi-Dimensional Emotional Empathy Scale (Caruso & Mayer 1998). The empathy scale has statements such as "It hurts to see another person in pain" and "I rarely take notice when people treat each other warmly". Listeners rated how much they agreed with the statements on a 5 point scale, (1 – Strongly Disagree, 5 – Strongly Agree).

Three blind raters from Mechanical Turk rated the quality of each of the listeners' retellings on a scale from 0 - 100, where 0 meant the listeners seemed to remember nothing from the story, and 100 meant the listeners seemed to remember the story word from word.

Analysis to be implemented by me

I worked with data from the study described to gain a deeper sense of understanding of the relationships between interpersonal synchrony, implicit mood, explicit mood, empathy, and memory quality.

The ERP and EDA measures taken during the listener and story-telling tasks were used to look at correlations associated with synchrony. Synchrony between speaker and listener is defined as resemblance (correlation) between their physiological activity being time-locked to the auditory story for ERP data and EDA data.

Higher numbers on the implicit and explicit mood measures indicate happier scores, and lower numbers indicate sadder scores. Likewise, higher numbers on the empathy scale indicate higher levels of empathy.

Memory quality was measured by averaging the memory scores assigned by each of the 3 blind raters for each story. Interrater reliability scores were reported.

I averaged the data from the ERP, EDA, implicit mood, explicit mood, empathy, and story memory measures by subject and by valence of the story. Happy and sad stories were analyzed separately.

Results

I predicted that the degree of synchrony between speaker and listener for both the ERP and EDA measures would correlate positively with empathy scores and memory scores for happy stories. To test this prediction I used the data processing program, JASP and computed the strength of correlation between speaker and listener for the happy story task ($r(14) = 0.113$, $p = 0.677$). (See figure 1).These values imply a slight positive correlation, though not statistically significant. I predicted that the degree of synchrony between speaker and listener for both the ERP and EDA measures would correlate positively with empathy scores and negatively with memory scores for sad stories. I computed the strength of correlation between speaker and listener for the sad story task ($r(14) = -0.284$, $p = 0.286$). (See figure 2). These values imply a slight negative correlation, though not statistically significant.

I predicted that story memory will correlate positively with explicit and implicit mood for happy stories, and negatively for explicit and implicit mood for sad stories. I computed the strength of correlation between story memory and explicit mood for the happy story task ($r(14) = 0.027$, $p = 0.920$) (see figure 3) and story memory and implicit mood for the happy story task ($r(14) = 0.289$, $p = 0.277$). (See figure 4). These values imply a slight positive correlation between explicit mood and memory and implicit mood and memory, though not statistically significant. I computed the strength of correlation between story memory and explicit mood for the sad story task ($r(14) = -0.351$, $p = 0.182$) (see figure 5) and story memory and implicit mood for the sad story task ($r(14) = -0.306$, $p = 0.250$). (See figure 6). These values imply a slight negative correlation between explicit mood and memory and implicit mood and memory, though not statistically significant.

I also computed the correlation between explicit mood and implicit mood, to understand deeper how each listener's moods were recorded. The explicit mood and implicit mood scores were computed for the happy story task ($r(14) = -0.351$, $p = 0.182$). (See figure 7).These values imply a slight positive correlation, though not statistically significant. The explicit mood and implicit mood scores were computed for the sad story task ($r(14) = -0.351$, $p = 0.182$). (See figure 8). These values imply a slight positive correlation, though not statistically significant.

Discussion

This analysis was done to gather more information on the research done in the original study. I strived to analyze the data to further understand the relationship between empathy, interpersonal synchrony, implicit mood, explicit mood, and memory of happy and sad stories. Synchrony between speaker and listener was measured by the use of EDA and ERP measures during story-telling and story-receiving. I predicted that there would be a positive relationship between degree of synchrony, empathy scores, and memory scores for the happy story task. I predicted that for the sad story task, there would be a positive relationship between synchrony and empathy scores and a negative relationship between synchrony and memory scores.

I found this was the case, thus implying that when listeners connected with the story being told, they empathized, and the measures indicated high brain synchrony. However, when it was a sad story, listeners might not have encoded the story to memory as well as listeners hearing happy stories, because the sad stories were distressing to hear. I also found that there was a positive correlation between memory and mood for the happy story task and a negative correlation between memory and mood for the sad story task. These results further demonstrate the relationship between brain synchrony and empathy and portrays how distress can lead to poor memory encoding.

To measure mood, an explicit and implicit mood task were provided to each listener. Since there was a positive correlation between explicit and implicit mood, it can be concurred that these measures, (Brief Mood Inventory and face morphing task) are indeed reliable measures to indicate mood. Therefore, the listeners' mood scores are reliable and express how they felt after hearing each story.

If this study was replicated, it would be beneficial to include more listeners. The present data only includes sixteen subjects, and if there were more the results might indicate statistically significant values and correlations. Unfortunately, I did not have access to all the data resulted from the original study. It would have been interesting to look at more specific values, such as relationship between actual content of the stories, other than sad and happy. I also wonder how the way the speakers told their stories effected synchrony. If a speaker and listener were not synchronized, it is possible one reason could be low level of enthusiasm and uninterested tone of voice the speaker displayed.

It is a relevant, real-world situation for a person to hear a recording of a story – whether it be on a tape or listening to a presentation that is not live. The results of this study further demonstrate how brain synchrony is occurring in communication, specifically between a recording of a speaker's story, and the listener.

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Figures

Figure 1. This graph shows the relationship between ERP synchrony and EDA synchrony in speakers and listeners for the happy story task.

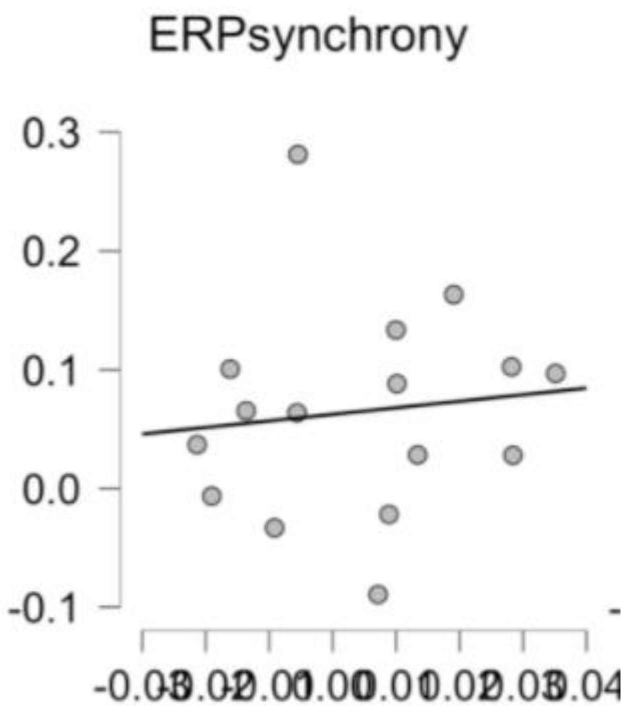

Figure 2. This graph shows the relationship between ERP synchrony and EDA synchrony in speakers and listeners for the sad story task.

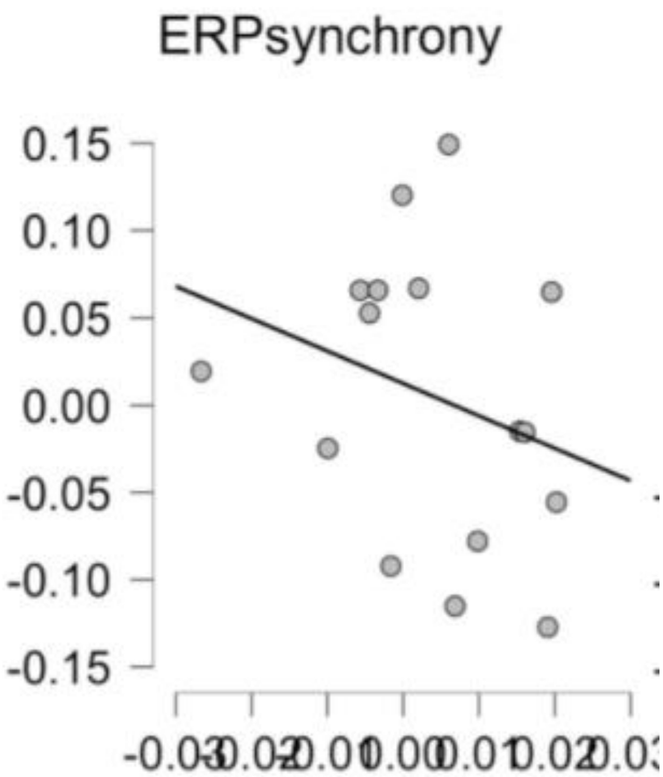

Figure 3. This graph shows the relationship between story memory and explicit mood for the happy story task.

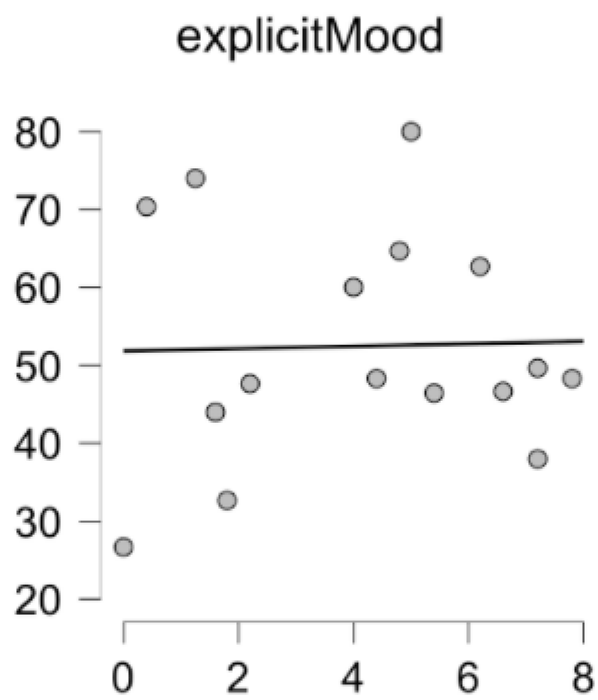

Figure 4. This graph shows the relationship between story memory and implicit mood for the happy story task.

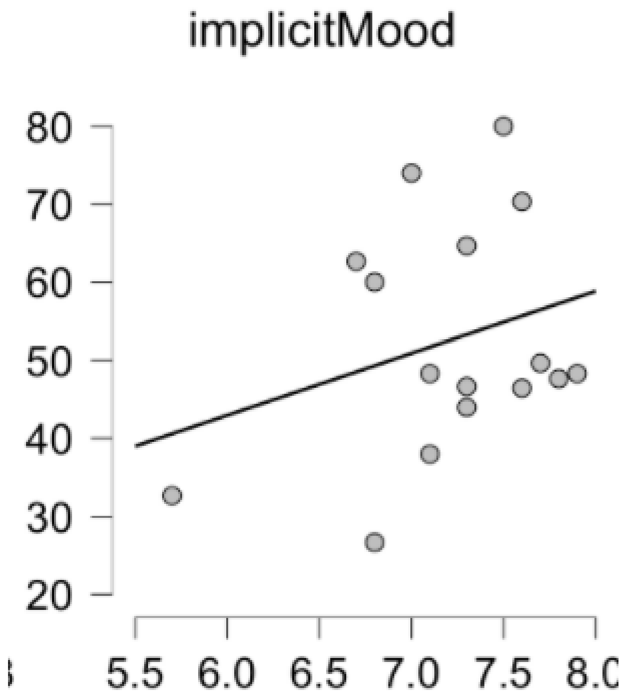

Figure 5. This graph shows the relationship between story memory and explicit mood for the sad story task.

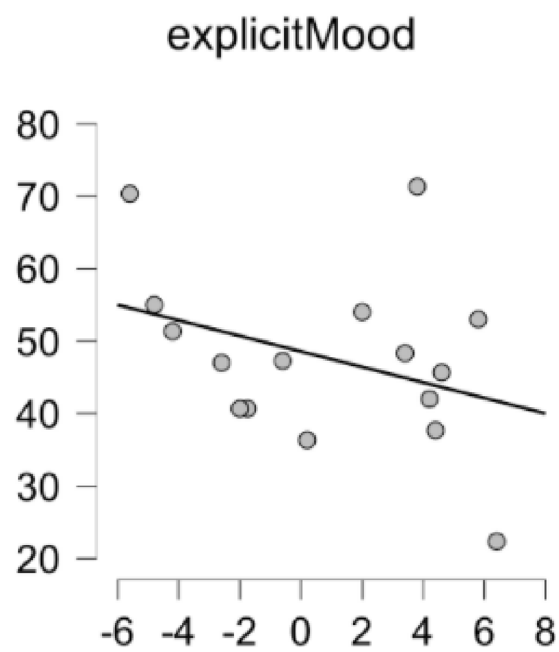

Figure 6. This graph shows the relationship between story memory and implicit mood for the sad story task.

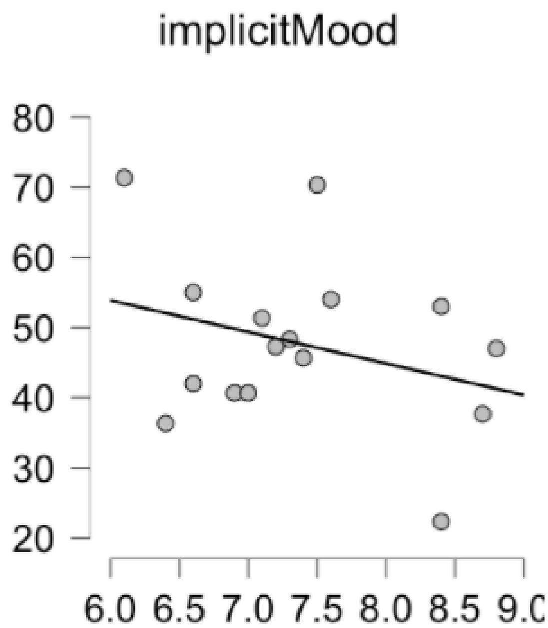

Figure 7. This graph shows the relationship implicit mood scores and explicit mood scores for the happy story task.

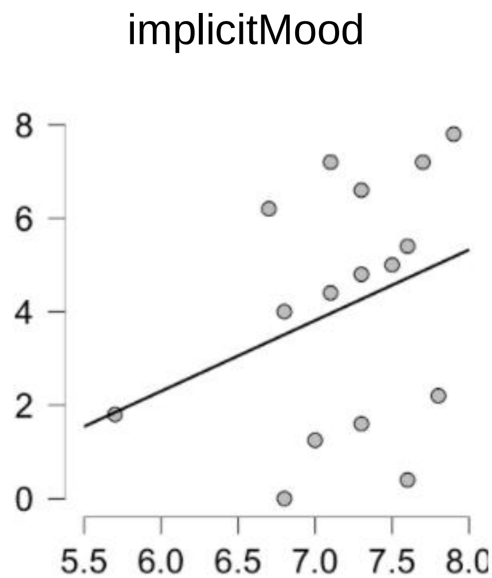

Figure 8. This graph shows the relationship implicit mood scores and explicit mood scores for the sad story task.