EXPLICIT AND IMPLICIT MEASUREMENT OF MIND PERCEPTION IN SOCIAL ROBOTS THROUGH INDIVIDUAL DIFFERENCES MODULATION

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By

İmge Saltık

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We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ABSTRACT

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June 2022

The attribution of mental states to the object or subject that an individual interacts with according to its appearance or behavior is called mind perception [1]. Recent research on human-robot interaction has shown that robots can create mind perceptions like other agents under certain conditions. In addition, while the two dimensions of mind perception (Agency and Experience) are mostly controlled using explicit measurement methods in the literature, the use of implicit measurement methods in the measurement of mind perception is still almost nonexistent. In addition to this fundamental gap, studies examining mind perception in robots have investigated how appearance affects mind perception, while the effect of action perception almost again has never been observed. In this context, we investigated how robots affect mind perception by manipulating differences in action and appearance. Methodologically, we conducted our study using both the explicit measurement method and the implicit measurement method due to the gap in the literature. In this study, individual difference measurement was also used to observe the causes of different attributions in mind perception to robots. In the first study, participants (N=102) evaluated how the robots' performing different actions (biological, verbal and nonverbal communicative and neutral) and appearance (humanoid and mechanical) affect mind perception; in the second study, participants (N=185) evaluated the effect of robots' actions and appearances on mind perception in terms of implicit and explicit measurement methods. In addition, 11 individual difference measures were used to observe individual differences that modulate mind perception. Looking at the results, it has been observed in both studies that the action of robots affects mind perception. In the explicit measurement method, neutral behavior was found to create less mind perception than communicative and biological action. In the implicit measurement method, differences in reaction time were observed between communicative actions and biological & neutral actions. Individual differences that modulate the perception of the explicit and implicit mind have been observed. According to this, intentionality of behavior, theory of mind, and perception of loneliness are core modulates for explicit mind perception, while negative mood primarily modulates implicit mind perception. Looking at the results, it was observed that the perception of action had an effect on the mind perception, the implicit and the explicit mind perception showed different patterns from each other, and the individual differences predicted the pattern of implicit and explicit mind perception.

Keywords: Mind Perception, Human-Robot Interaction, Action Perception, Explicit and Implicit Measurements, Individual Differences.

ÖZET

SOSYAL ROBOTLARDA AÇIK VE ÖRTÜK ÖLÇÜMLÜ ZİHİN ALGISININ BİREYSEL FARKLILIKLAR MODÜLASYONU

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Haziran 2022

Bireyin etkileşimde bulunduğu nesnenin veya öznenin görünüşüne veya davranışına göre zihinsel durumların atfedilmesine zihin algısı denir [1]. İnsan-robot etkileşimi üzerine yapılan son araştırmalar, robotların belirli koşullar altında diğer özneler gibi bireylerde zihin algısı oluşturabildiğini göstermiştir. Ayrıca, literatürde çoğunlukla zihin algısının iki boyutu (Yetkinlik ve Hissiyat) açık ölçüm yöntemleri kullanılarak kontrol edilirken, zihin algısının ölçümünde örtük ölçüm yöntemlerinin kullanımı halen neredeyse yok denecek kadar azdır. Bu temel boşluğa ek olarak, robotlarda zihin algısını inceleyen çalışmalar, görünümün zihin algısını nasıl etkilediğini araştırırken, eylem algısının etkisi yine neredeyse hiç gözlemlenmemiştir. Bu bağlamda robotların eylem ve görünümdeki farklılıkları manipüle ederek zihin algısını nasıl etkilediğini araştırdık. Metodolojik olarak literatürdeki boşluktan dolayı hem açık ölçüm yöntemi hem de örtük ölçüm yöntemi kullanılarak çalışmamızı gerçekleştirdik. Bu çalışmada robotlara yönelik zihin algısındaki farklı atıfların nedenlerini gözlemlemek için bireysel farklılıklar ölçümü de kullanılmıştır. İlk çalışmada, katılımcılar (N=102), robotların farklı eylemleri (biyolojik, sözlü ve sözsüz iletişimsel ve nötr) ve görünüşü (insansı ve mekanik) gerçekleştirmesinin zihin algısını nasıl etkilediğini değerlendirdi; ikinci çalışmada, katılımcılar (N=185) robotların eylemlerinin ve görünüşlerinin zihin algısını üzerindeki etkisini örtük ve açık ölçüm yöntemleri açısından değerlendirdi. Ek olarak, zihin algısını modüle eden bireysel farklılıkları gözlemlemek için 11 bireysel farklılık ölçütü kullanıldı. Sonuçlara bakıldığında her iki çalışmada da robotların hareketinin zihin algısını etkilediği gözlemlenmiştir. Açık ölçüm yönteminde, nötr davranışın iletişimsel ve biyolojik eylemden daha az zihin algısı yarattığı bulundu. Örtük ölçüm yönteminde, iletişimsel eylemler ile biyolojik ve nötr eylemler arasında reaksiyon süresinde farklılıklar gözlemlendi.

Açık ve örtük zihnin algısını modüle eden bireysel farklılıklar gözlemlenmiştir. Buna göre, davranışın amaçlılığı, zihin teorisi ve yalnızlık algısı, açık zihin algısı için temel modüller iken, olumsuz ruh hali öncelikle örtük zihin algısını modüle eder. Sonuçlara bakıldığında, eylem algısının zihin algısı üzerinde etkisi olduğu, örtük ve açık zihin algısının birbirinden farklı örüntüler gösterdiği, bireysel farklılıkların örtük ve açık zihin algısı örüntüsünü yordadığı görülmüştür.

Anahtar sözcükler: Zihin Algısı, İnsan-Robot Etkileşimi, Eylem Algısı, Açık ve Örtük Ölçümler, Bireysel Farklılıklar.

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Atakan Gümüşbaş, who is a big part of my life; my better half, everything you have contributed to me in 3 years is present in this thesis - *patience, love, passion, joy* and *trust*, which will be with us in an *implicit* form. Thank you so much for enlightening all the bad times with your presence and beautiful smile.

At every stage of this thesis, the world went to different places, and in the whole process, everyone struggled to take the changing world to a better place and to understand it deeply beforehand. Throughout this whole process, I motivated myself to be who I wanted to be, and I thank myself for writing this thesis without ever giving up. In the future, I hope that this work you are doing these days will make you stronger.

"There's a point, around the age of twenty, when you have to choose whether to be like everybody else the rest of your life, or to make a virtue of your peculiarities."

— Ursula K. Le Guin, The Dispossessed (1974, *p.249*)

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Chapter 1

Introduction

1.1 Mind Perception

Social cognition is the foundation of the human mind. Thanks to the social cognition modules, we can define the items that identify the "human" form. Every module that enables interaction is a small but essential part of this cognition. One of the abilities we use when we interact is our ability to attribute cognition to objects or subjects. Mind perception is when individuals attribute specific mental capacities to the object or subject they interact with. Gray and his research team [1] contributions form the basis of studies on interaction in this respect. Mind perception mainly consists of 2 dimensions. Agency - defined as mental capacities that have the power to do something; Experience - defined as mental capacities that are empowered to feel something. This study defines the mental capacity competencies of the Agency dimension as self-control, morality, memory, emotion recognition, planning, communication, and thought and of the Experience dimension as hunger, fear, pain, pleasure, rage, desire, personality, consciousness, pride, embarrassment, and joy. Whether these capacities are high or weak depends on the form of traits (e.g., robots, wild or pet animals), their features (e.g., the way they look - whether they have a face or the shape of their limbs), or the way they behave (e.g., fluid movements, fast or slow, normative or random patterns) is shaped accordingly. That is, the listed capacities (1) can exist to a certain degree; rather than being defined as existing or absent, they can be defined as more or less, (2) instead of all listed capacities being attributed as a whole at once, only specific capacities can be attributed to an entity. In this context, the object or subject takes a value between 0 and 1 infinity in a linear plane for each Agency and Experience dimension (Figure 1.1).

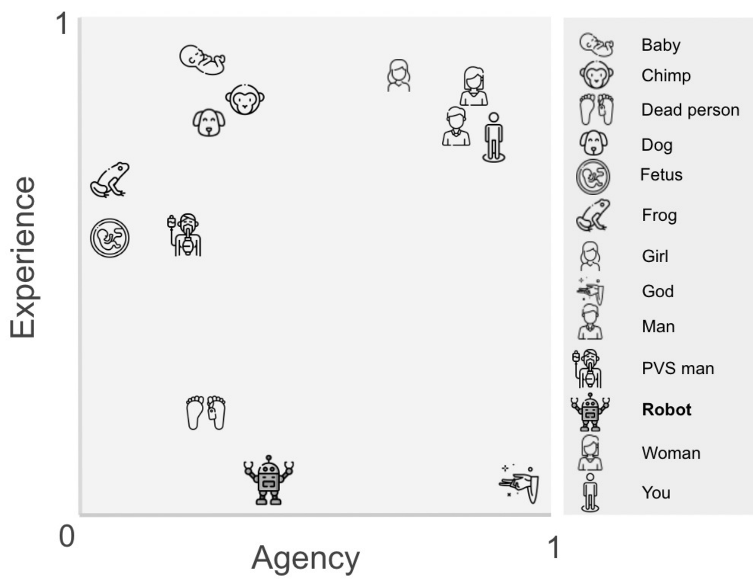

Figure 1.1: **Graph of different agents in order of mind perception dimensions.** In the study carried out by [1], 13 different agents were examined in terms of how much mind perception they have over 2 dimensions (Agency & Experience). From [1], p. 619. Reprinted with permission from AAAS.

It is important to point out the causes and consequences of mind perception while defining this term [2] (Figure 1.2). It is thought that there are two primary causes of mind perception in the perceivers. First, due to causal uncertainty in the world, people want to understand the individual they interact with and predict and control their behavior. The second is that people want to establish a social bond with the individual they interact with. For the first cause, when one sees contrary behaviors somehow together, the perceiver will want to sense these behaviors in a pattern. For example, the unexpected waving by a person walking on the street may be rendered meaningless by the perceiver, leading the perceiver to think that the waving person is mindless. However, uncertain behavior will make sense to the perceiver if the waving person is actually doing it for a purpose like chasing a fly, which will turn the action into a mindful behavior from the perceiver's perspective. In this example, the subject behaves in a way that demonstrates its capacities in the Experience dimension. The second cause that triggers mind perception is social attachment motivation. As [3] argue, if a perceiver feels more socially vulnerable, one follows the facial mimics and tone of voice of the subjects in front of them more carefully and is more channeled to the mental capacities of the subject. This situation can create a more sensitive mind perception and a more intense mind perception attribution.

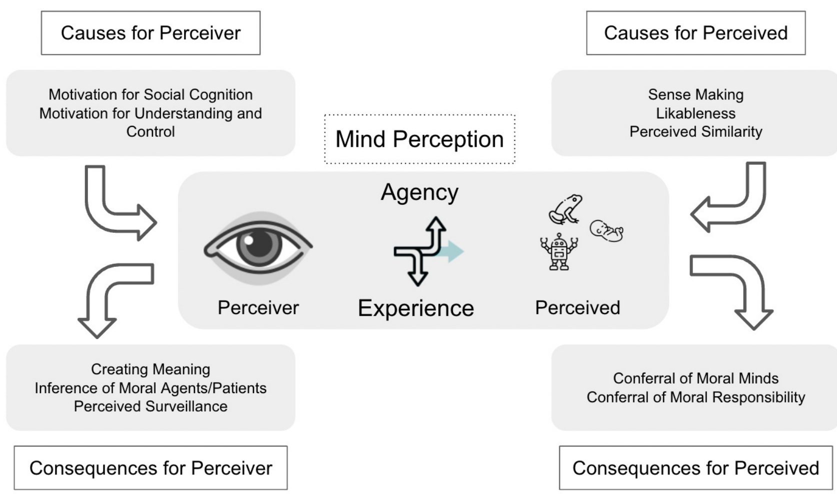

Figure 1.2: **Causes and consequences of mind perception.** It evaluates the causes and consequences of mind perception in terms of perceiver and perceived. While the perceiver agent is in the observer position, the perceived agent is in the observed position. Here, the causes are gathered under 2 main headings, and the importance of social cognition and social bond is emphasized. There are 3 main consequences: meaningfulness of behavior, acceptance by society, and prosocial motivations. Reprinted, with permission, from ref. [2] p. 384. See Appendix.

Although the perceiver is more active in mind perception, the perceived object also has a position in this equation in terms of causality. By nature, human beings interact more with objects that resemble and behave to themselves; therefore, in/out-group relations also shape the mind perception. Subjects, who are in the perceived position and out-group, are exposed to less mind perception [4] [5]. Neuroimaging research in humans shows that when the perceived subjects are out-group members, the medial prefrontal cortex (MPFC), a brain area considered the basis for social cognition [6], lacks activation. Another study reports that people attribute more minds to entities similar to themselves and that during the mind attribution process, there is more activation in the brain region responsible for self-referential thoughts (especially the ventral medial prefrontal cortex (vmPFC)) [7]. Just as in the out-group context, when the perceived person is objectified by focusing only on her behaviors, her mind perception may be reduced [8], or the ratio of dimension score is reversed in the plane (her Agency score decreases while her Experience score increases) [9].

When we look at the consequences of mind perception, three main consequences are observed [2]. First of all, it is thought that people experience their interactions with mind-attributed individuals more intensely and give meaning to them by paying more attention. For instance, there are very different mental processes between throwing a tree branch to the perceiver and the same tree branch being dragged by the wind and falling in front of the perceiver. Throwing a tree branch by someone with a "mind" requires a particular intention and mental capacity, and the behavior itself turns into purpose. However, the same branch hitting the perceiver due to the wind is evaluated only as a coincidence, devoid of any intention and mental capacity. The second consequence is the tendency of a person to exhibit socially acceptable behaviors in communication with an individual to whom the mind is attributed. Some studies showed that the perceiver is aware of being watched by someone with a mental capacity who will socially judge her behaviors, which affects the pattern of her behaviors [10] [11] [12]. The third consequence is the search for moral understanding in individuals to whom the mind is attributed. A person with mental capacity is expected to know what is morally right and wrong and act accordingly. The main motivation here is the perception that a person with mental capacities should directly bear moral responsibilities. For example, when a mother abandons her child, she is accused of cruelty and immorality, whereas a cat abandoning her kitten is a natural process and does not make emotional sense.

The "social brain" theory plays an explanatory role [13] when we look at the effect that behaviors have on the mind perception . There are 3 key elements essential here; social perception, action observation, and theory of mind [14]. The posterior superior temporal sulcus (pSTS) is the main module of these observed triple elements. The other regions include the prefrontal cortex (PFC), anterior cingulate cortex (ACC), and temporoparietal junction (TPJ) [15] [16] [17] [18]. Also, face perception is very important in the context of synchronization and attributing the mind to others. In the studies of [19] on FFA (the fusiform face area) and social attribution activation, it was observed that the amygdala, temporal pole, medial prefrontal cortex, inferolateral frontal cortex, and superior temporal sulcus regions were also active during the attribution process with the FFA activation of normal individuals. A social process is also neurally activated by the perception of faces. These areas are intersecting and important brain areas for attributing mind perception to others. Specific research has been conducted based on these regions. [20] suggest that the medial prefrontal cortex (mPFC) and the temporoparietal junction (TPJ) connect superior temporal sulcus (STS) activity. The posterior superior temporal sulcus (pSTS) is sensitive to the intention of the movement in front of the subject and whether that movement is suitable for the context in which it is found. In the study conducted by [21], it was found that the pSTS responds to the purpose of the movement of the moving subject without being animate or inanimate. This result reinforces the importance of movement in mind attribution; goal-oriented perception passes through the pSTS, which is a core region in social brain theory, and as a result, it can be said that the goal of the movement and the context of the movement are important in mind perception, beyond kinematics.

The study by [22] showed that the ventromedial prefrontal cortex (vmPFC) plays a role in mind attribution and social attention, and this role is effective in top-down modulation of low-level social-cognitive processes. It is observed that the right temporo-parietal junction (RTPJ) region works mainly on attention for mind attribution its activation selectively includes mind-reading context, and it is not activated in any other social context so much [23] [24] [25] showed that with their fMRI study, some definite parts in the RTPJ region and the region close to the RTPJ region are activated for mind attribution. By combining eye-tracking and fMRI methods, a recent study demonstrated that gaze direction shapes activation in the medial prefrontal cortex (MPFC) and anterior temporoparietal junction (TPJ). Accordingly, what we look at affects our mind perception of attribution [26].

1.2 Mind Perception and Social Robotics

There are very few studies that study mind perception induced by robots. In one of the pioneering mind perception studies using the two-dimensional Agency and Experience plane, [1] observed that a robot agent receives a low score in the Experience dimension and a medium score in the Agency dimension (Figure 1.1). In the study of [27], robots were examined in more detail in the concept of mind perception, and it was reported that the physical appearance of robots, especially human-like or non-human-like appearances, affects the mind perception of robots. According to this study, people attribute greater mental capacity to robots with a more human-like appearance than those with non-human-like appearance, especially in the Experience dimension.

[28] stated that another factor affecting the mind perception of robots is the behavior patterns of robots. Accordingly, robots displaying unpredictable behaviors were attributed with more mental capacity than robots displaying predicted behaviors. Another study showed that the robot's features affect the mind perception of robots [29]. The researchers compared the mind perception of the humanoid robot in 2 different context groups. Accordingly, humanoid robot visuals were compared with standard robot visuals in the robot context group, and humanoid robot visuals were compared with human visuals in the human context group. The results showed that the humanoid robot visuals created more mind perception than the standard robot visuals in the robot context group but still did not surpass human visuals in mind perception. Considering the causes and consequences of mind perception, it can be said that humanoid robots can be more active in forming social bonds (because it is more human-like than a standard robot) and increase mind perception. In a recent overall comprehensive

study, [30] explored mind perception towards robots with a wide range of robots (251 robots in total). The primary motivation was to understand the importance of the appearance and behavior of robots in mind attribution. As shown in this study, the fact that the robot has a body causes it to refer to certain mental capacities in terms of the Agency dimension, while the appearance of the face and surface (for example, having skin) is a feature that specifically increases the Experience dimension.

Current studies examine the attribution of minds to robots with different procedures. Studies in the literature are mostly based on self-judgment reports, so new methods and procedures are being tried. Mind perception was controlled through language processing and implicit procedure, apart from self-report. Studies in language look at how quickly people use mental attribution in their word choices, while implicit measurement procedures look at how quickly behavioral responses are processed. If the internal process finds consistency between the explicit stimuli, a shortening of the reaction time is observed. If there is incompatibility, the reaction will be prolonged. [31] used linguistic measurement (conceptional descriptions of participants) as a new methodology to measure mind perception other than self-report. Participants observed the behaviors of robots and humans, and the expressions they used while describing the agents' mental states were examined. As a result, participants attributed the mind to two agents in different manners; they used different conceptual mind descriptions for both humans and robot agents. In terms of intention and mental states, humans and robots differ in the description; it has been determined that the conceptual description used is specific at different points (causes for humans and causality for robots) and that it is used at different rates (desires for humans, but not the difference between in intention and desire for robots). Ultimately, it seems that there is a process both explicitly and linguistically in attributing minds to robots. Similarly, [32] analyzed the words and explanations used by the participants and implicitly measured the extent to which they attribute minds to robots. In the study, the researchers created a Mind Perception Dictionary (DMP) and examined participants' level of mind attribution to the other Agency based on their words. In the section involving robots, the results show that certain mental capacities are used more intensely for humans to distinguish robots from humans but still, people can be attributed to certain mental capacities from the appearance and behavior of robots. The research group [33] wanted to examine implicit mind perception of robots from a new and different perspective. Specifically, they tried to establish a link between explicit and implicit results by adapting the IAT to mind attribution. Here, the basic procedure is whether there is a relationship between reaction time and mind attribution; if there is, they wanted to show whether it is compatible with explicit mind attribution. The results indicated that robots implicitly received less attribution of mind than humans; however, explicit and implicit results do not show a correlation.

From a neuroscientific point of view, there are few but important studies on how robots' behavior triggers mind perception. For instance, [34] showed that the intentional or mechanical interpretation of robots' behavior can be differentiated and predicted in the resting EEG beta wave. More specifically, the resting-state EEG beta activity of the participants was recorded before the study, and they knew they would only see one robot in the study. In the study, they had to interpret robot behavior as intentional or mechanical. The results showed that people who interpreted robot behavior more mechanically had a higher beta wave. These differences in beta waves were observed especially in the left temporoparietal cluster and the right frontotemporal cluster. Regarding the theory of mind, the gamma wave was examined, and the difference was detected 250 ms in waves before the participants' reaction. Greater dyssynchrony was found in the occipitotemporal cluster of people who found robot behavior more mechanical.

The Default Mental Network (DMN) is a symmetrical network that is active when the brain is at rest and no central activation is seen [35]. Activation of the Default Mental Network (DMN) theory displays the person's internal reflections (memory, self-reference, morality, and emotion) [36]. According to DMN theory, the internal dynamics of many modules actually trigger each other at a resting state. As [34] had discussed, in the literature, beta-band oscillations (13 to 30 Hz) are a reliable index of spontaneous cognitive processes in the conscious and at rest position, and importantly, it is strongly associated with cortical regions in the Default Mental Network (DMN). The study shows that there may be self-reflective mentalization with higher beta wave levels in the resting state; therefore, dyssynchrony may occur in attributing intentionality to an external agent, robots.

1.3 Mind Perception and Individual Differences

There are several studies investigating individual differences in mind perception. In addition to studies on personality and intercultural differences [37] [38], group dynamics also contain individual differences in mind perception [39]. [37] studied how five major personality traits modulate mind perception. The results show that the agreeableness module is associated with high attributions in the Agency dimension; in addition, it has been observed that individuals with high neuroticism do not have attributions in the Agency dimension. [38] on the other hand, investigated how intercultural differences affect the perception of the mind. In the study, images of people from different ethnicities and individually from the same ethnic origin were extracted from an animatic image to a real human appearance for both ethnic groups using a series of morphs. As a result of the study, individuals attributed more minds to visual stimuli of their ethnicity in any case, whereas individuals of other ethnicities attributed more minds to visual stimuli that were more human (non-animatic). In [39] study on in-group and out-group dynamics, in- and out-group faces were manipulated with a series of morphs. The results show that the mind attribution threshold to in-group visual stimuli is faster, and easier and the mind is attributed when out-of-group visuals appear much more realistic. Another finding was that as people felt more belonging to their group, the threshold for attributing the mind to the visual stimulus in the outgroup increased. This study demonstrates a bottom-up process for contextual information to attribute to the mind.

In addition, how modules such as dehumanization [40], loneliness [41], or intention of behavior [42] differ individually on mind perception were also examined. Considering the study conducted by [40] on how dehumanization modulates mind perception, it was seen that individuals perceived dehumanized subjects lower in terms of mind perception. In addition, it was shown that subjects that received low mind attribution from the participants got lower scores, especially in the Experience dimension. As shown in the causes of mind perception, attachment propensity is a factor that can increase mind perception. A study by [41] showed that people began to attribute more minds to non-human beings as the perception of loneliness increased. It has been shown that with the increase in social and attachment motivation, more non-human objects are attributed mind by the participants who felt loneliness. Finally, [42] examined how intentionality of action affects the mind's perception. The results showed that if participants attributed more intent to the action, they attributed cognition to the subject performing the action. In the study, also, when the participants took the perspective of the subject performing the action, the participants did not attribute more mind to the subject; however, it was observed that the intention of the movement increased. When all these mentioned results were examined, it was seen that individual differences might play a role in the mind perception. These differences come from socio-cognitive bases and show that the individual differences, along with the properties of the agents, can also modulate mind perception.

1.4 Individual Differences and Social Robotics

Studies that reveal individual differences in human interactions with robots have been increasing in recent years [43] [44] [45] [46] [47]. [43] show individual differences (when viewed through anthropomorphism) in attributing human characteristics to robots: robots with more human traits are expected to be more morally responsible, trustworthy, and socially competent. In another study, [44] showed that individual differences in anthropomorphism are associated with the different volumes of the left temporoparietal junction (TPJ), which plays a role in the theory of mind. The results showed that tendency to anthropomorphize another agent might be associated with mental attribution; thus, high gray matter volume in the temporoparietal junction (TPJ) correlated with more anthropomorphizing of the agents. [45] examined the individual differences in the interaction of the elderly with robots. The study running a robot prototype trial in aged care homes showed that the elderly who attributed more minds before the use of robots were more inclined to use them after use. These results showed that different attitudes towards robots can be determinative in the use of robots.

In one of the more recent studies, [46] examined the eeriness and warmth ratings towards robots through individual personality traits. According to the results, Anxiety and Personal Distress traits significantly predicted android eeriness, but these traits did not predict warmth. [47] in their 2019 study, showed the importance of individual differences, especially in cooperation with robots. The study aimed to measure individual differences in the attitude towards robots, specifically on how faithful they can be while performing a task in physical interaction with robots. The results showed that the more negative attitudes individuals have towards robots, the less they interact and cooperate with the robot while performing the task.

Apart from these studies, some studies study individual differences in mind perception of robots through cultural differences [48] [49]. [48] in their 2014 study, examined the attitude and perception of trust towards robots in two different cultures (Australia and Japan). Contrary to the fact that familiarity can bring more positive perceptions and more confidence, Japanese participants had more negative attitudes and felt less confidence than Australian participants in interacting with the robot. Likewise, in the study conducted by [49] the perception of Japan and Germany toward social robots was investigated. The results showed that while Japanese participants attributed more minds in the Experience dimension to robots, Japanese and German participants attributed minds in the Agency dimension similar to each other. In this study, contrary to general belief, Japanese participants did not display a more positive attitude (due to familiarity) towards robots than German participants. When examining the results in general, it is seen that individual differences can modulate the attitude towards robots and the ability to cooperate. The degree of attributing the mind forms the basic attitude and the basis of cooperation more than familiarity.

1.5 Research Gap in Literature

When the studies on mind perception, social robots, and modulating individual differences in the literature are examined in detail, there are still significant gaps in knowledge. These gaps can be examined in 3 parts. (1) The extent to which the behavioral pattern of social robots (e.g., type of activities or actions they do) influence mind perception has not been visited; (2) studies examining the mind perception generally rely on self-report measures, and more work is needed to understand mind perception with implicit measures and how they compare to explicit measures; (3) a comprehensive study on individual differences and how they predict explicit and implicit measures do not exist.

1.6 Aim of the Study

There are three main goals in this study. The first goal is to investigate whether the type of actions a robot performs modulates mind perception (Study 1). To this end, we used robots that perform 4 different actions in 2 appearances. We had a human-like robot and a mechanical robot, which performed the following actions: a biological action (human behavior), a verbal communication behavior (humanoid behavior), a non-verbal communication behavior (humanoid behavior at a lower degree), and a neutral behavior (any non-human behavior).

The second goal is to record explicit and implicit measures of mind perception in response to robots with different appearances and actions (Study 2). The mind's perception towards robots with different appearances and different degrees of action has never been examined with an implicit measurement. So, this is one of the main contributions of our study to literature.

The third goal of our study is to understand the individual differences in mind perception towards robots, both with explicit and implicit measures. 11 individual difference modules that could predict mind perception towards robots will be used.

Chapter 2

Action and Agent Types & Mind Perception to Robots

2.1 Methods

2.1.1 Participants

102 university students participated in the study (2 participants were excluded;vfor the remaining participants, age range: 18 – 35 years old, Mean age = 21.8; SD = 2.37; 62 Female). All of the participants had normal or corrected-to-normal vision and hearing. Before the study, the participants signed the consent form approved by the Bilkent University Human Subjects Ethics Committee and received course credit for their participation.

2.1.2 Stimuli

The stimuli used in the study consisted of 2-sec videos of two robots, each performing the very same actions (Figure 2.1). Videos were taken from the Saygin

& Ishiguro Robot Database [50] [51] [52] [53].

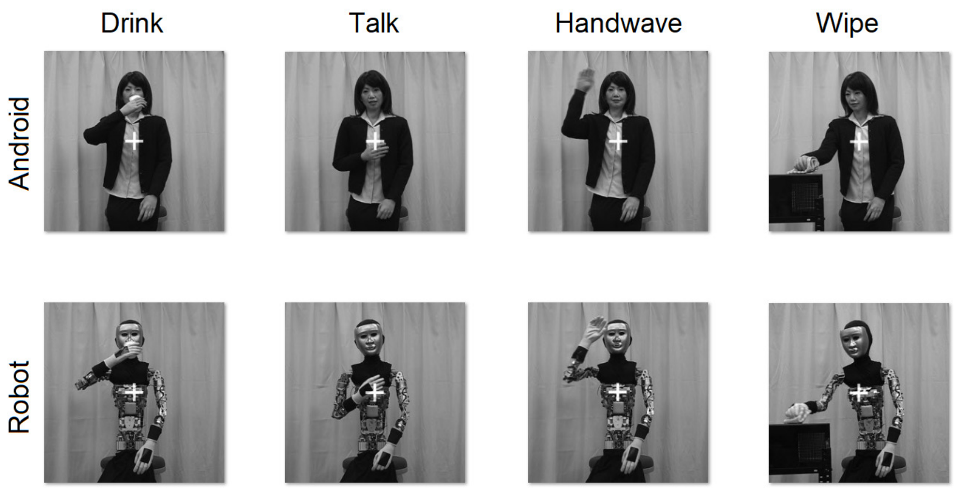

Figure 2.1: **Visual stimuli for Study 1.** Two appearances are shown as humanoid (android) and mechanical (robot), actions are shown as biological (drink), verbal communication (talk), non-verbal communication (handwaving), and neutral action (wiping).

2.1.3 Design

Two factors were manipulated to investigate their effects on mind perception. The first factor was the appearance of the robot agent, which was a between-subject variable and had two levels: mechanical (Robot agent, see Figure 2.1) and human-like (Android agent, see Figure 2.1). The second factor was the action that the robot agent performs. It was a within-subject variable and had four levels: (1) an action indicating a biological need - Drinking, (2) an action involving verbal communication - (Talking), (3) an action involving non-verbal communication – Hand waving, (4) an action in which an object is manipulated - Wiping. The motivation of using these action categories was the fact that they were common actions that we observe in daily life and varied in terms of their potential to induce mind perception in the observers. Drinking is an action that is typically performed by biological agents including humans and other animals for a biological need, and has the potential to be associated with possessing a mind. Introducing oneself to another agent by talking is a uniquely human action, and is hypothesized to induce mind perception. Handwaving is typically performed by humans as a way of non-verbal communication although some forms of it may be possessed by other animals such as non-human primates. Therefore it has the potential to be associated with mind perception. Object manipulation such as wiping is an action that could be performed by humans and others, and is the category that is hypothesized to be least associated with mind perception. Participants were randomly assigned to the Robot or Android condition. Each participant viewed the videos of one of these agents, but all participants viewed all of the four actions of the respective agent. The dependent variable of the study was mind perception. It was construed to have two dimensions, Agency and Experience, as in prior research [1]. Mind perception was measured using a 12-item questionnaire based on the studies by [1] [54]. Questions are given in statements. The extent to which the stimulus that the participants saw is suitable for this statement is measured by the Likert measurement. The questions were evaluated on a 7-point Likert scale ("0 - Never" to "6 - Ever").

Table 2.1: Mind Perception Questionnaires

Agency Dimension	
Morality	This robot can know the difference between good and bad actions.
Emotion Recognition	If this robot sees someone happy/sad, [it] can understand these feelings.
Self-control	If this robot moves, [it] chooses to move.
Memory	This robot is capable of remembering.
Thought	This robot is capable of thinking.
Self	This robot thinks for [it]self.
Experience Dimension	
Pleasure	This robot can feel pleasure.
Fear	If this robot saw a snake, [it] would be scared.
Hunger	If this robot has not eaten breakfast, [it] may feel hungry.
Pain	If I squeezed the arm of this robot, [it] might feel pain.
Consciousness	This robot is capable of being aware of things.
Personality	This robot is capable of having personality traits that make [it] unique from others.

In line with previous research [1] [54] [55], we performed factor analysis to confirm the dimensions underlying the 12-item questionnaire and scored each dimension using the items loaded under each factor (See the details in 2.2.1 section in Results). Note that, the language we presented the items (Turkish) is a gender-neutral language, i.e. the third person singular pronoun does not imply a gender or animacy like in English (he/she/it). Therefore, when describing the agent in the sentences of the questionnaire, no implicit animacy could be attributed to the robot (it vs. she/he).

2.1.4 Procedure

The call for the study was made through a collective mailing list covering all students and staff affiliated with the university. Participants who responded to the call were randomly assigned to one of the two groups, the study was conducted with the between-subject method. According to the G*power [56] sample size analysis (repeated measures ANOVA with 95% β power and 5% for α), the number of participants required in each group was 36. The number of people in the groups were kept equal, 50 people were assigned to the Robot condition and 50 people to the Android condition. In case of possible data exclusion, 10 more people were tested for each group, more than the number shown on G*power [56].

Participants were familiarized with the videos before taking part in the Mind Perception Questionnaire. They were shown 8 videos (2 agents x 4 actions) and told what each video depicted. Next, they did the Mind Perception Questionnaire on a computer. Each participant viewed four different action videos of one of the agents in a random order and answered the 12 questions for each video. Afterwards, the demographic information was taken and the experiment was terminated.

2.1.5 Data Analysis

Although earlier research characterizes mind perception as having two dimensions, Agency and Experience, with specified items under each dimension ([1]; also see 2.1.3 Design section above), later research has questioned the characterization of these dimensions [55]. In particular, some items have been thought to lie in the intermediate zone between Agency and Experience. These items are shown as Personality, Consciousness, Thought and Communication. It is suggested that the less the difference in factor loading of an item between the two dimensions, the more it falls into the intermediate zone. Therefore, instead of putting each item in the questionnaire under a pre-defined Agency or Experience category a priori, we first did exploratory factor analysis (EFA) on our data. Factor analysis provided us the dimensions (factors) in our data and which items went under which dimensions. Once we determined the dimensions in data for factor analysis, we computed the mean scores of each dimension by averaging the scores of the items under each dimension in each subject. Then we ran 2 (Agent) x 4 (Actions) mixed ANOVA for the scores of each dimension; Agency Experience.

2.2 Results

2.2.1 Factor Analysis of Mind Perception Questionnaire

The first aim was to check whether the Turkish version of the Mind Perception Questionnaire had a structure with two factors, as Agency and Experience. To this end, we conducted exploratory factor analysis (EFA) on the 12 items in the questionnaire. The results showed that the 12 items were loaded on two factors as it was in the English version [χ^2 (43, N = 100) = 169.290. p <.001, KMO = 0.843, RMSEA = .18, 90% CI [0.145 0.2]), TLI = .743, BIC = -28.732]. Cronbach's α values of the scale were found as .89 for Agency and .88 for Experience.

An important distinction of the results from the English version was that some items were loaded under the other category. In particular, "Personality" and "Consciousness" items were in the Experience dimension in the original study; whereas they were loaded below the Agency dimension in the Turkish study (factor loads Personality 0.67; Consciousness 0.92 in Turkish study). Likewise, "Thought" and "Emotion Regulation" were below the Agency dimension in the original study, but it is observed below the Experience dimension in the Turkish study (factor loads Thought 0.57; Emotion Regulation 0.86 in Turkish study). The remaining 8 items were loaded in parallel with their location in the original study. The factor structure of the Turkish Mind Perception Questionnaire is shown in Table A.1. Therefore, the sub-scoring of Agency and Experience categories were done based on this factor structure, and behavioral analysis was done using the items in these categories.

2.2.2 Action Type & Mind Perception

For the Agency dimension, there was a main effect of action (F (3, 288) = 6.403, p <.001, $\eta^2 = 0.008$). Post-hoc tests (Bonferroni corrected) indicated that participants rated the wiping action significantly lower than the other three actions – drinking water (t = 3.156, p <.05, 95% CI [0.042 0.489]); self introducing (t = 4.200, p <.001, 95% CI [0.130 0.576]); and hand-waving (t = 2.683, p <.05, 95% CI [0.002 0.449]).

Table 2.2: Post Hoc Comparisons - Actions in MP - Agency

		Mean Difference	SE	t	p_{bonf}
DR	TL	−0.041	0.079	−0.518	1.000
	HW	0.059	0.079	0.745	1.000
	WP	0.307	0.079	3.879	< .001
TL	HW	0.100	0.079	1.263	1.000
	WP	0.348	0.079	4.397	< .001
HW	WP	0.248	0.079	3.133	0.011

* p < .05, p < .01, *** p < .001

For the Experience dimension, Mauchly's test indicated that the assumption of sphericity had been violated (χ^2 (5) = 61.662, p <.001), therefore appropriate corrections were made using Greenhouse-Geisser correction. The result showed that there was a main effect of the action type (F (2.266, 217.576) = 3.476, p <.05, $\eta^2 = 0.005$). Post-hoc tests (Bonferroni corrected) indicated that the wiping action was significantly lower than drinking action (t = 3.156, p <.05, 95% CI [0.033 0.389]), but there was no significant difference between the verbal (t = 2.012, p >.05, 95% CI [-0.043 0.313]) or non-verbal (t = 1.342, p >.05, 95% CI [0.090 -0.088]) communication actions.

Table 2.3: Post Hoc Comparisons - Actions in MP - Experience

		Mean Difference	SE	t	p_{bonf}
DR	TL	0.025	0.064	0.390	1.000
	HW	0.126	0.064	1.966	0.301
	WP	0.177	0.064	2.762	0.037
TL	HW	0.101	0.064	1.576	0.697
	WP	0.152	0.064	2.372	0.110
HW	WP	0.051	0.064	0.796	1.000

* $p < .05$

2.2.3 Agent Type & Mind Perception

For the Agency dimension, there was no effect of agent ($F(1, 96) = 2.974$, $p > .05$). For the Experience dimension, there was no effect of agent ($F(1, 96) = 2.449$, $p > .05$).

2.2.4 Action Type & Agent Type Interaction

For the Agency dimension, there was no interaction of agent and action ($F(3, 288) = 0.952$, $p > .05$). For the Experience dimension, there was no interaction of agent and action ($F(2.266, 217.576) = 0.413$, $p > .05$).

2.3 Intermediate Discussion

As a result of this study, the effect of robot actions and appearances on mind perception was measured. In the study, actions as in a spectrum in the form of a 4 reference point; from biological to a neutral behavior, and appearance as a 2 reference point in the same way as in the literature; the humanoid and the mechanical appearance were manipulated. The results were looked at for each action over the ratings attributed to mind perception. Here, 2 robot appearances were examined as a group. The action was the main focus of this study, as the action of robots has rarely been studied by mind perception in the literature.

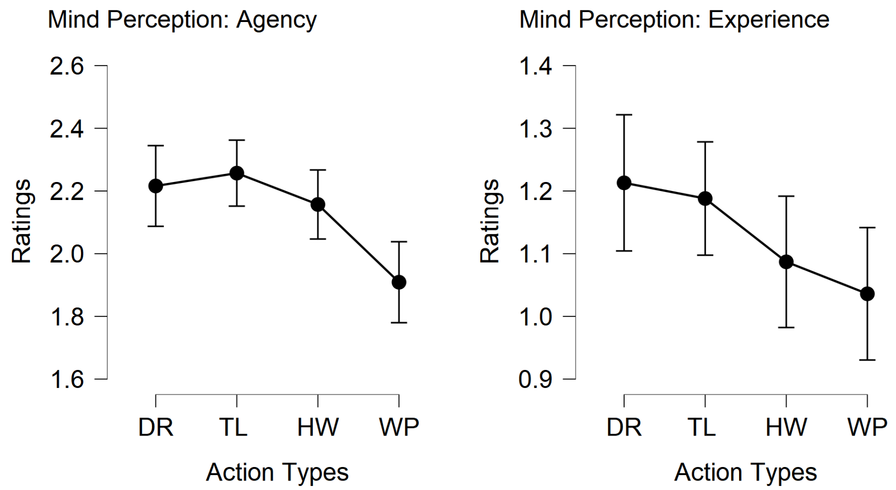

Figure 2.2: **Mind perception results depending on actions.** Neutral action (WP) was rated significantly lower than biological (DR) and communicative actions (TL and HW) in both dimensions. Details of 4 actions, DR: Drink, TL: Talk, HW: Handwave, WP: Wipe.

With repeated measures mixed ANOVA, the effect of 4 behaviors in 2 appearances for two dimensions of mind perception was examined.

In addition, since the Mind Perception inventory was measured in Turkish in this study, reliability and factor analysis were also performed. Within the scope of the study, exploratory factor analysis (EFA) was applied, and Cronbach's alpha values were examined in order to determine to what extent the sub-components of the two-dimensional, Agency and Experience dimensions, which [1] brought to the literature, provide a measurement in Turkish.

Looking at the modulation of agent actions on mind perception, for the Agency dimension, it was found that neutral action (wiping) creates less mind perception towards more human-like actions across the spectrum. In other words, performing humanoid behaviors (drinking or communicating) can lead to more minds being attributed to robots in terms of the Agency dimension. For the Experience dimension, performing a neutral action led to less mind perception than a biological action. However, no such result was observed between the communicative

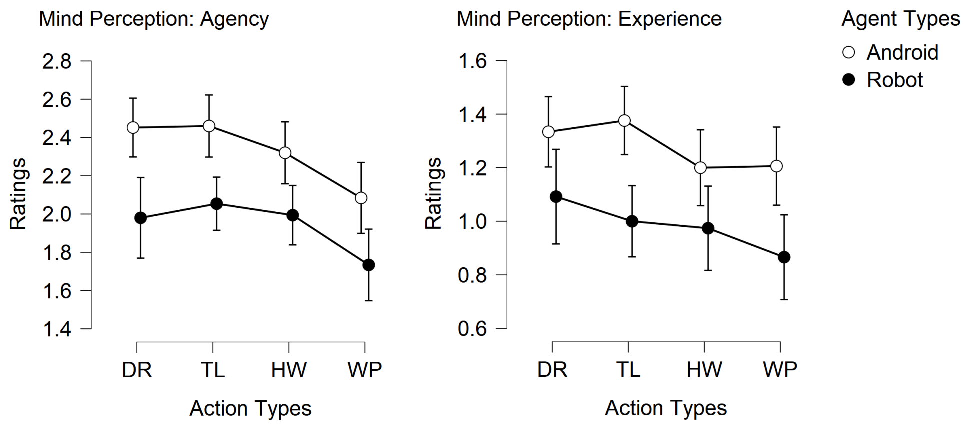

Figure 2.3: **Mind perception results depending on actions and agents.** The difference between the agents did not show a significant result in both dimensions.

actions and the neutral action. According to this result, performing a biological action may lead to more minds being attributed to robots than a neutral action in terms of the Experience dimension. This result does not apply to communication actions against neutral action.

Looking at the modulation of agent appearances on mind perception, this study observed that the two appearances did not affect the dimensions of mind perception. Although this finding overlaps with the literature, it can be seen that the most important reason might be the between-subject design of the study. No effect was observed when people were not exposed to the appearance of another robot to compare. However, the primary reason for using this design is that it forms the basis of this research into whether the behavior of any robot will have an effect. The underlying question has not been experimentally discussed in the literature. With these results, it has been shown that the robot's behavior in any view affects mind perception. In addition, no interaction was observed between the agent's appearance and the behaviors.

When we look at the factor loadings and validity study of mind perception, the original inventory consisting of 12 sub-items was provided in Turkish, 8 of which were consistent, and 4 of the sub-items were replaced. In this context, for the Agency dimension, while Self, Self-control, Memory, and Morality are already compatible with the original work, Personality and Consciousness were transferred from the Experience group to the Agency group in the Turkish study. For the Experience dimension, while Fear, Pleasure, Hunger, and Pain are already compatible with the original work, Thought and Emotion Regulation was transferred from the Agency group to the Experience group in the Turkish study.

Chapter 3

Explicit and Implicit Mind Perception to Robots & Individual Differences

3.1 Methods

3.1.1 Participants

185 university students participated in the study (Age range: 18 – 40 years old, Mean Age = 22.04; SD = 3.14; 127 Female; 1 Non-binary). All of the participants had normal or corrected-to-normal vision and hearing. Before the study, the participants signed the consent form approved by the Bilkent University Human Subjects Ethics Committee and received course credit for their participation.

3.1.2 Individual Differences Parameters

Individual differences that may affect people's perception of robots are discussed in the literature [57] [58], but there is no study that examines these differences in parallel with mind perception. In this study, individual differences were measured under 11 sub-headings. It was investigated whether the data obtained from these tests were the determining in the mind perceptions of the participants. These tests and their explanations are listed below.

These tests were done in Turkish. The Turkish versions of some of the tests have reliability tests and references are given. For those who have not yet been translated into Turkish, the Turkish translation process was performed and a reliability test was performed. In any case, all of the tests within the scope of the thesis were tested for reliability in this study. In addition to these tests, the effects of education level, job status (or department, if university student), age, gender and familiarity with robots were also examined in terms of seeing participants' demography.

3.1.2.1 Autism-Spectrum Questionnaire (ASQ) [59][60]

Autism is a condition characterized by difficulties in three distinct domains, including impairments in social abilities and communication, and repetitive, stereotypical behavior. Since socialization creates the mind perception, the effect of poor social skills has been need to investigate. The Autism Spectrum Questionnaire (ASQ) was designed to measure autism-related qualities in adults on the normal spectrum [59]. The Autism-Spectrum Questionnaire consists of 50 questions in total by asking 10 different questions to evaluate 5 different areas. These 5 different areas; social skills, shifting attention, attention to detail, communication and imagination. A 4-point Likert type scale was used in the test. For questions in each area, the participant's giving 1 point indicates that they are closer to the Autism Spectrum. Autism-related behaviors measured in the test can be listed as poor social skills, poor communication skills, poor imagination, attention to detail, inability to control attention, or too much focus of attention. It was used to measure whether people would attribute more minds to a robot with the application of this test being more prone to the Autism Spectrum.

3.1.2.2 Body Consciousness Test (BCT) [61]

People can show certain differences in the extent to which they realize their subjective physical existence. There are distinct individual differences in public or self-consciousness in determining this existence. These two tendencies, public and self-consciousness, are measured by the Body Consciousness Scale. Since body perception can be generated by other entities, it is a question how this perception can modulate mind perception. Individuals evaluate their own subjective and externally specific body consciousness and evaluate with a 6-point Likert scale under the 16-question "Special Body Consciousness, Body Competence, Social Body Consciousness" sub-headings. In this study, it will be used to measure the awareness of how much the person is aware of his physical body and how much his size occupies. With this scale, it will be useful to see how body awareness personally evaluates another object.

3.1.2.3 Behavior Identification Form (BIF) [62][63]

The Behavioral Identification Form is a tool designed to measure individual differences in the level of evaluation of actions. Each item in the BIF presents a transaction identity and two alternative identities, one based on a lower and higher intent essence; participants should choose the alternative that best describes the action for them (for example, if listening to the lecture is an action, the two alternative intentionality identities can be summarized as 1- learning something (high level); 2- sitting in the lecture row (low level). While the first alternative contains a high perception of intention in the action, the second alternative tends to the form of the action and the intention rate is low). Individual differences in action definition level are based on the assumption that people reliably differ from one another in their overall action competence. Low-level subjects can claim real expertise in relatively few areas of action and must treat their behavior with attention to detail. Higher-level subjects, by contrast, may have gained expertise in many fields of action and may continue to act with higher-level identities in mind. In this context, it is important to reach how the participants personally evaluated the actions in this study. The measurement consists of low and high level evaluations of 25 actions.

3.1.2.4 Individual Differences in Anthropomorphism Questionnaire (IDAQ) [43]

Anthropomorphism means attributing human characteristics to inanimate objects. Anthropomorphism is important for creating an empathetic connection with non-human subjects, judgments of responsibility and guilt, and social impact. Thus, anthropomorphism ascribes capacities that humans think of as distinct from non-human subjects, specifically human-like mental capacities. People, for example, may think of an animatic robot as depressive, but this is not an all-encompassing attribution. There are different levels of mental attribution on the basis of anthropomorphism [41]. How robots' appearance or behavior is modulated in anthropomorphic trends is a question mark. The IDAQ questionnaire provides a psychometrically valid measure of anthropomorphism. The IDAQ is measured on a 30-item 11-point Likert scale (0 - Not at all; 10 - A lot). In the scale, 15 questions consist of noise questions and the remaining 15 questions are used to measure anthropomorphism.

3.1.2.5 Interpersonal Reactivity Index (IRI) [64]

Empathy refers to the individual's internal emotional responses to the emotional conditions of others [65][64][66][67][68]. The IRI assesses the multiple cognitive and emotional components of dispositional empathy. It will be investigated whether empathic orientations produce a sense of mind for robots. IRI dimensions consist of Perspective Taking (PA: considering others' perspectives) and Fantasy

(F: identifying with fictional characters in books and movies). Affective dimensions include Empathic Worry (EE: sympathy for those in need) and Personal Distress (KS: self-focused, negative arousal in response to others' distress). Participants answer the IRI, which consists of four categories, using a 5-point Likert scale (5-point Likert scale: 0 - Doesn't describe me at all; 4 - Describes me fully). This test will also be used to evaluate people's empathy levels multidimensionally.

3.1.2.6 Multidimensional Assessment of Interoceptive Awareness (MAIA-2) [69][70]

Inner awareness, which is the nervous system's process of perceiving, interpreting and integrating signals from the body, has become an important research topic for mental health and especially mind-body interventions. The Multidimensional Assessment of Interoceptive Awareness (MAIA) is a self-assessment questionnaire under 8 sections with 32 items to measure multiple dimensions of inner awareness. Test is completed on a 6-point Likert scale (6-point Likert scale: 0 - Never, 5 - Always). The importance of this test in our study is to measure whether the participants develop a sense of vitality to the opposite object through their inner awareness.

3.1.2.7 Mechanical Self Dehumanization Scale (MSDS) [71]

Dehumanization of one's self can be thought of as the rejection of physical and internal self-perception in the mental process and its consequences. To explain it with a practical definition, we can express it as a person's seeing herself/himself as deprived of the mental capacity that she sees as a human being, and also her deprived treatment. The importance of mental capacity perception here, not perceiving the person herself/himself as a human being and not attributing mental processes can make us think in terms of looking at her as non-human. This is why self-dehumanization is so important to how we perceive the mental processes of others. The MSDS was developed to measure attribution of human nature (HN) traits to the self. Inspired by [72] model of dehumanization, this

13-item scale is measured on a 9-point Likert scale.

3.1.2.8 Negative Attitudes Towards Robots Scale (NARS) [73][74]

Negative attitudes towards robots are considered as one of the psychological factors that prevent people from interacting with robots in daily life. NARS was developed to measure people's attitudes towards communication robots in daily life. In this context, it is used to evaluate the attitude towards social robots that enter our daily lives. NARS consists of 14 questions that can be divided into three subscales: negative attitude towards interacting with robots, negative attitude towards the social impact of robots, and negative attitude towards emotions interacting with robots. Participants rated how well each statement represented their attitude on a 5-point Likert scale.

3.1.2.9 Positive and Negative Affect Scale (PANAS) [75][76]

Examining the mood structure in all existing cultures, two dominant dimensions have emerged consistently. [75] presented a two-factor model that could serve as a basis in this context; these are factors often referred to as positive emotions and negative emotions. The characteristics of these two dimensions can roughly match the personality factors associated with extroversion and introversion. Therefore, in this study, PANAS will assess the personality traits of individuals measured through emotions. Personality occupies an important place in the scope of the mind, and this measurement will show to what extent the characters of the people will have an impact on our mind attribution. PANAS includes 20 moods (10 positive, 10 negative) and how people currently and generally approach these moods are evaluated on a 5-point scale (1 - Very little or not at all [does not fit the individual]; 5 - Extremely or a lot [fits the individual]).

3.1.2.10 Reading Mind in Eyes Test (RMET) [77][78]

It is believed that RMET benefits from ”mind reading” abilities, which is an important aspect of ”Theory of Mind” [77]. Theory of mind can be defined as the cognitive capacity to make inferences and/or produce mental representations about the mental state of the self and others. The test measures the mental structures expressed by the eyes and thus relies on complex mental capacity perception. RMET consists of 32 images and 4 adjectives for each image. The person completes the test by identifying the correct adjective that describes the eyes in the image. In this study, it will be examined to what extent people read the perception of the mind from the eyes and the Theory of Mind relationship that they establish with the object in front of them.

3.1.2.11 UCLA Loneliness Scale-3 (ULS-20) [79][80]

Loneliness is a situation that occurs when a person is alienated from people in terms of his/her position in life. The UCLA loneliness scale measures how people evaluate themselves in this context. In the total 20 question scale, 9 questions measure the context outside of self loneliness (for example, closeness to family, friends or social environment), while 11 questions evaluate the interiority of loneliness. The measurement is made with a 4-point Likert measurement (1 - Never; 4 - Always). This test will determine the position of the person in the environment in our study and will infer the importance of personal loneliness in the mental attribution task. We can summarize it as follows, living alone and living in a multi-person household can lead to different valuation of the concept of person and this test is a controlled method in measuring the position loneliness in perception of mind.

3.1.3 Stimuli for Explicit and Implicit Mind Perception

The same robots used in the first study were also used in this study. For explicit measurements, 4 different behaviors in the first study were used in the same way. For implicit measurements, 4 different behaviors were added in the study stimuli (Figure 3.1). Added 4 extra behaviors for noise stimuli in the implicit measurement. Videos were taken from the Saygin & Ishiguro Robot Database [50] [51] [52] [53]. The same robots were used for explicit and implicit measurements.

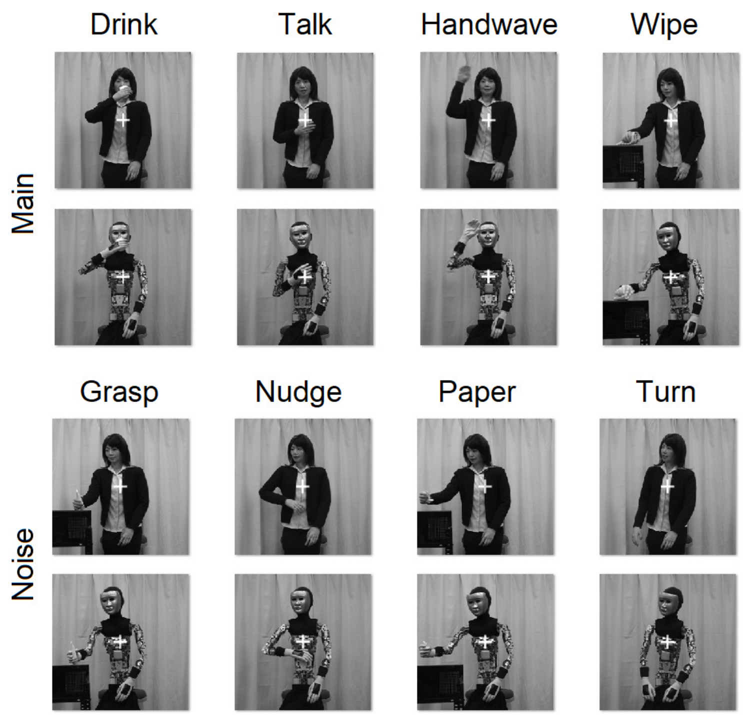

Figure 3.1: **Visual stimuli for Study 2.** Two appearances are shown as humanoid (android) and mechanical (robot), the main actions are shown as biological (drink), verbal communication (talk), non-verbal communication (handwaving), and neutral behavior (wiping). The filler actions are used for EPT procedure. The main reason for adding 4 extra neutral actions is that the subjects did not understand which actions were being tested. This made the procedure more difficult so that participants did not find the measurement easy and understand what is being measured. The filler actions are shown as neutral actions (grasping an object, turning to the left, nudging someone, throwing the paper).

3.1.4 Design

The variables manipulated in the first study are used in this study. The different appearances and behaviors of the robots were tested on mind perception as two dimensions; mechanical and human-like appearance four different action styles in behavior. The first factor was the appearance of the robot agent, which was a within-subject variable and had two levels: mechanical (Robot agent, see Figure 3.1) and human-like (Android agent, see see Figure 3.1). The second factor was the action that the robot agent performs. It was a within-subject variable and had four levels: (1) an action indicating a biological need - Drinking, (2) an action involving verbal communication - Talking, (3) an action involving non-verbal communication – Hand waving, (4) an action in which an object is manipulated - Wiping. Main appearance and behavior were kept constant as in the first study. Added 4 different behaviors to create noise only in implicit measurement; (5) picking an object off the table - Grasping, (6) manipulating an object with the arm - Nudging, (7) throw away paper - Paper, (8) looking to the right - Turning.

As in the first study, the main 4 behaviors fall on the spectrum from a biological imperative to a neutral behavior. The act of drinking water is a basic biological behavior and is only seen in living things. 2 basic communication behaviors; talking and hand waving takes place on two levels, verbal and non-verbal. The final and neutral behavior involves interacting with an object as a cleaning table. Noise behaviors are added to make the level more difficult in implicit measurement, so that participants do not understand what is being manipulated. None of the behaviors with noise involve basic social motivations. The main reason for this is that participants are expected to see more social or biological behaviors in the actual measured behavior group. Participants saw all the robots in this study. No conditions were used. In this study, mind perception was considered as an independent variable; Agency and Experience dimensions were evaluated as two different dimensions [1] The questionnaire, which is used to measure mind perception, was reduced from twelve to eight in this study. The main difference here is due to the fact that some items are not translated into Turkish according to the results of the first study (Table A.1).

One of the two main differences that stood out in the Turkish translation study was (1) that not all factor loads were loaded; (2) each factor was not represented in its own group (See section 2.3.1 Factor Analysis of Mind Perception Questionnaire for details). Originally, 12 items were divided into 6 Agency and 6 Experience items. These items are for Agency; morality, emotion recognition, self-control, memory, thought, self; for Experience; pleasure, fear, hunger, pain, consciousness, and personality. Within the scope of this study, 8 items were divided into 4 Agency and 4 Experience items. These items suitable for Turkish are for Agency; morality, self-control, memory, personality; for Experience; pleasure, fear, hunger, pain. The questions were evaluated on a 7-point Likert scale ("0 - Never" to "6 - Ever"). In this study, the language was again kept neutral and it was defined as a direct robot without using any animate or inanimate pronouns (it vs she/he). As a secondary dimension, both explicit and implicit measurements were taken into account. It is not just the differences of the variables manipulated on the declaration data (explicit); the change in response time (implicit) representing cognitive load was also examined through variables.

3.1.4.1 Evaluative Priming Test (EPT)

The Evaluative Priming Test (EPT) created by [81] for implicit measurement was adapted for this study. EPT is a research technique that reveals "implicit" relationships between different concepts by "preparing" people with words or images and then having people categorize the words or images after the stimulus. The stimuli that will primarily prepare for the application (priming) are determined. Then, the stimuli to be categorized are determined depending on the visuals that prepare them. It is also called in literature as a bona fide pipeline measure [81].

In this context, in our study, the stimuli are robot images, and the stimuli to be categorized based on the visuals are mind perception words. The application consists of 5 blocks. In this exercise, participants are told to take a recall test so their attention is manipulated. The main purpose of this is so that people do not realize that an implicit measurement has been made. Before starting the study, the participants are told that there are 2 tasks, the first is the task of correctly and quickly parsing the words to be categorized, and the second task is to keep in mind the images they will see and answer them in the right way by saying "I saw or I did not see" when the time comes.

The exercise in the first block of the study is the practice of familiarization with the words of mind perception. Participants are introduced to 2 categories and the items of the categories. Agency (Yetkinlik) and Experience (Hissiyat) are 2 categories from this study, the items below are for Agency; morality, self-control, memory, personality; for Experience; pleasure, fear, hunger, pain. After people have settled on which category the items belong to, the block is completed in 8 trials. The main motivation here is to explain to the participants that the items should not be memorized; the aim is to learn the logic of mind perception items and to sort them into categories intuitively. The purpose of this block is to get participants used to reacting with the keyboard and Experience category matching with items. Matching categories is done using the RIGHT and LEFT arrow keys of the computer keyboard. They must respond within 3000 milliseconds for each item. Items are given randomly.

In the second block of the study, the participants are told to watch only the next images. In this section, 8 images (Robot performing 4 actions; Android performing 4 actions) are randomly displayed on the screen for 1500 milliseconds. Participants are told to look carefully at the screen and keep in mind the images they see. The aim here is to familiarize the participants with the visuals. The purpose of the recall test is; (1) they do not understand what we are manipulating; (2) that the robot appearances and behaviors, which are the details in the visuals, are especially noticed by the participants. In this section, only the visuals are passed and the participants watch carefully.

In the third block, in order for the experiment to be meaningful to the participant, 16 images are shown in a mixed form and asked which ones they have seen or not. 16 visuals contain every behavior in the data set. Of these, 8 visuals should say "I saw" (images for each actor -Robot and Android-, drinking, talking, hand waving and wiping), 8 visuals should say "I didn't see" (for each actor -Robot and Android-, grasping, nudging, paper, turning). It does not matter here whether the participant actually remembers – the participant just needs to be familiar with the visuals and understand that the behaviors are different in the experimental design.

The fourth block acts as the main block for the experiment. In this section, the participants saw one of the 8 priming stimuli as a random priority, and they immediately saw one of the 8 mind perception items. This process is done one by one for all 8 visual stimuli to 8 mind perception stimuli. That is, the participant will have seen 64 (8x8) trials within the block. The aim here is to get a reaction on behalf of each mind perception element for each robot visual. The participants are first shown the visual stimulus (robot images) for 300 ms, and then the mind perception item comes in the interval of 3000 ms and is asked to categorize it. During the entire block, 2 times 7-second rest breaks were given.

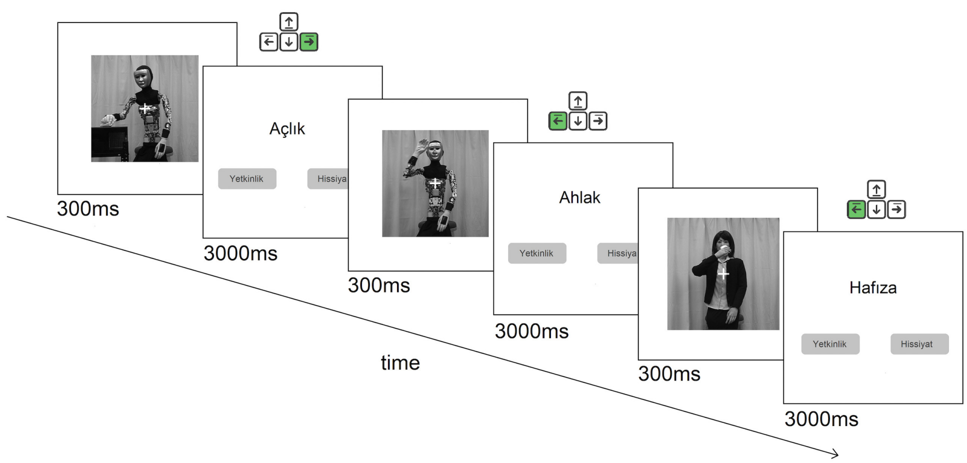

Figure 3.2: **EPT procedure.** Flow of Block 4: the participants saw the visual stimulus for 300 ms in which both robots perform 4 different behaviors as primer. Primers are paired with each mind perception item and the reaction time (RT) is taken within 3000 ms. In this context, 8 primer and 8 mind perception items (64 trials) are randomly paired and displayed one by one to take RT.

The purpose of this block is that the previously prepared stimuli create an interaction in the mind and it is expected to affect the reaction time when the words to be categorized come. In this context, if the robot different actions is incompatible with the word, it creates a delay in reaction time since it is not implicitly associated in the mind. For example, if the robot wiping the table visual and “Pain” from the Experience items create a mismatch, more than a normal delay will occur, the reaction time will be delayed. But in the same way, if the robot talking visual is compatible with the pain item, it can create a normal reaction time or even a quick reaction, because the harmony relationship is implicitly established in the mind.

In the fifth and last block, Block 3 is repeated again. In order for the experiment to be meaningful for the participant, 16 visual repetitions are shown to the participants in a mixed form and asked which ones they have seen or not. This is a pseudo block designed not only to finish with the previous block but also to create a complete recall test. Participants complete the EPT-Mind Perception measure inspired by the [81] Evaluative Priming Test in the implicit measure. The response times of the mind perception elements used in Block 4 to the visuals of both robots performing the actions are based on.

3.1.5 Procedure

The call for the study was made through a collective mailing list covering all students and staff affiliated with the university. The snowball method was also followed in order to reach more participants. Volunteers from the circles of the participants were also reached. The same procedure was followed for all participants, the study was conducted with the within-subject method. According to the G*power [56] sample size analysis (repeated measures ANOVA with 95% β power and 5% for α), the number of participants required in each group 175. In case of possible data exclusion, 10 more people were tested, more than the number shown on G*power [56].

Participants contacted the given e-mail address via e-mail. First of all, all individual difference tests were sent to the incoming voluntary participation emails. On average, 7 to 10 days per person were expected to resolve the tests. After completing the tests at any time in a comfortable and calm environment, the people contacted again that they had finished. The individual difference tests were followed up on Qualtrics and an appointment was made to meet online with the people who had completed all of them.

Appointment was given on online execution of Explicit and Implicit tests. Experimenters met with the participants via Zoom. Participants first completed the Implicit Mind Perception test, which was adapted over the EPT. After the first measurement was completed, the Explicit Mind Perception scale was used. Then demographic information was obtained. The study was terminated after debriefing was given to the participant who completed both tests.

3.1.6 Data Analysis

There are 2 parts in the analysis part of the study. In the first part, ANOVA was run for Implicit and Explicit scores one by one. For the explicit scores of the Agency items, the average score was calculated and we performed 2 (Agent) x 4 (Actions) repeated measures ANOVA. Likewise, for the explicit scores of the Experience items, the average score was calculated and we performed 2 (Agent) x 4 (Actions) mixed ANOVA. For the implicit scores of the Agency items, the average reaction time was calculated and we ran 2 (Agent) x 4 (Actions) repeated measures ANOVA. Likewise, for the implicit scores of the Experience items, the average reaction time was calculated and we ran 2 (Agent) x 4 (Actions) mixed ANOVA.

In the second part, it was analyzed whether eleven individual difference scores predicted dimensions and mind attributions on different bases. For this purpose, according to the inventory characteristics of eleven different individual difference scales, eleven participant-based average scores were obtained by looking at the original or, if any, Turkish translation of each scale. Average score was obtained on the Autism-Spectrum Questionnaire (ASQ) scale, average score was obtained on the Body Consciousness Test (BCT) scale, average score was obtained on the Behavior Identification Form (BIF) scale, average score was obtained on the Individual Differences in Anthropomorphism Questionnaire (IDAQ) scale, the mean score was obtained in the Interpersonal Reactivity Index (IRI) scale, average score was obtained in the Multidimensional Assessment of Interoceptive

Awareness (MAIA-2) scale, average score was obtained in the Mechanical Self Dehumanization Scale (MSDS), average score was obtained in the Negative Attitudes Towards Robots Scale (NARS), the average score for positive moods and the average score for negative moods were taken in the Positive and Negative Affect Scale (PANAS) scale, the average number of correct answers in the Reading Mind in Eyes Test (RMET) scale, average score was obtained on UCLA Loneliness Scale-3 (ULS-20) scale. Then, linear regression was applied for each dimension (Agency Experience) and measurement technique (Explicit & Implicit) based on eleven individual difference scores.

3.2 Results

3.2.1 Action Type & Explicit Mind Perception

For the Agency dimension, Mauchly's test indicated that the assumption of sphericity had been violated (χ^2 (5) = 18.804, p <.01), therefore appropriate corrections were made using Greenhouse-Geisser correction. The result showed that there was a main effect of the action type (F (2.799, 515.002) = 4.939, p <.01, $\eta^2 = 0.009$). Post-hoc tests (Bonferroni corrected) indicated that the wiping action was significantly lower than drinking action (t = 3.731, p <.001, 95% CI [0.042 0.247]), but there was no significant difference between the verbal (t = 2.458, p >.05, 95% CI [-0.007 0.198]) communication actions. There was a marginal significant difference between wiping and non-verbal (t = 2.598, p = .058, 95% CI [-0.002 0.203]) communication actions.

For the Experience dimension, Mauchly's test indicated that the assumption of sphericity had been violated (χ^2 (5) = 40.243,p <.001), therefore appropriate corrections were made using Greenhouse-Geisser correction. The result showed that there was a main effect of the action type (F (2.591, 476.657) = 3.228, p <.02, $\eta^2 = 0.005$). Post-hoc tests (Bonferroni corrected) indicated that the wiping action was significantly lower than drinking action (t = 2.782, p <.05, 95% CI

Table 3.1: Post Hoc Comparisons - Actions in Explicit MP - Agency

		Mean Difference	SE	t	Cohen's d	p_{bonf}
DR	TL	0.049	0.039	1.273	0.094	1.000
	HW	0.044	0.039	1.133	0.083	1.000
	WP	0.145	0.039	3.731	0.274	0.001
TL	HW	−0.005	0.039	−0.139	−0.010	1.000
	WP	0.095	0.039	2.458	0.181	0.086
HW	WP	0.101	0.039	2.598	0.191	0.058

* p < .05, ** p < .01

[0.005 0.187]), but there was no significant difference between the verbal (t = 0.255, p >.05, 95% CI [-0.83 0.100]) or non-verbal (t = 0.627, p >.05, 95% CI [-0.070 0.113]) communication actions.

Table 3.2: Post Hoc Comparisons - Actions in Explicit MP - Experience

		Mean Difference	SE	t	Cohen's d	p_{bonf}
DR	TL	0.087	0.034	2.527	0.186	0.071
	HW	0.074	0.034	2.155	0.158	0.189
	WP	0.096	0.034	2.782	0.205	0.034
TL	HW	−0.013	0.034	−0.372	−0.027	1.000
	WP	0.009	0.034	0.255	0.019	1.000
HW	WP	0.022	0.034	0.627	0.046	1.000

* p < .05

3.2.2 Agent Type & Explicit Mind Perception

For the Agency dimension, it was found that there was a main effect of agent (F (1, 184) = 51.649,p <.001, $\eta^2 = 0.098$). Post-hoc tests (Bonferroni corrected) indicated that participants rated the mechanical robot appearance significantly lower than the android robot appearance (t = 7.187, p <.001, 95% CI [0.257 0.452]).

Table 3.3: Post Hoc Comparisons - Agents in Explicit MP - Agency

		Mean Difference	SE	t	Cohen's d	p_{bonf}
A	R	0.355	0.049	7.187	0.528	< .001

*** p < .001

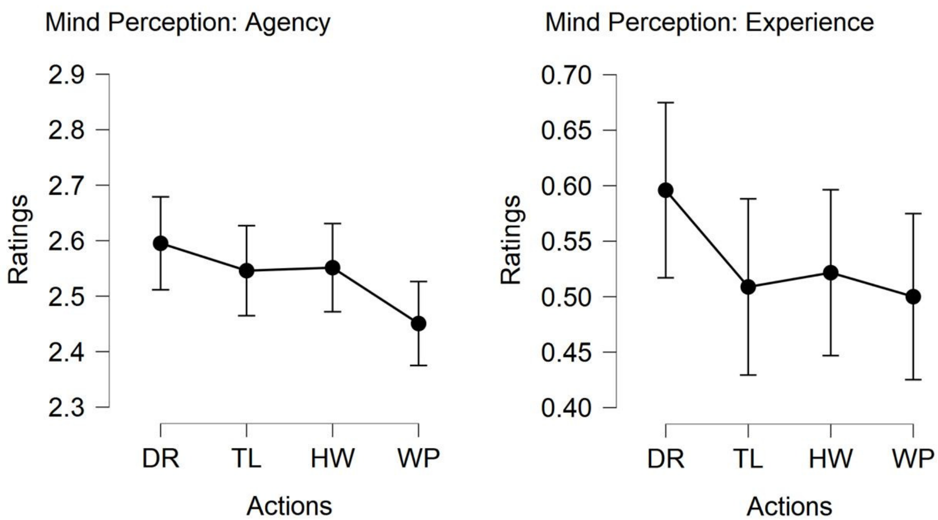

Figure 3.3: **Explicit mind perception results depending on actions.** Neutral action (WP) was rated significantly lower than biological (DR) but not for communicative actions (TL and HW) in both dimensions. Details of 4 actions, DR: Drink, TL: Talk, HW: Handwave, WP: Wipe.

For the Experience dimension, it was found that there was a main effect of agent (F (1, 184) = 36.842, p <.001, η^2 = 0.082). Post-hoc tests (Bonferroni corrected) indicated that participants rated the mechanical robot appearance significantly lower than the android robot appearance (t = 6.070, p <.001, 95% CI [0.200 0.393]).

Table 3.4: Post Hoc Comparisons - Agents in Explicit MP - Experience

		Mean Difference	SE	t	Cohen's d	p_{bonf}
A	R	0.296	0.049	6.070	0.446	< .001

*** p < .001

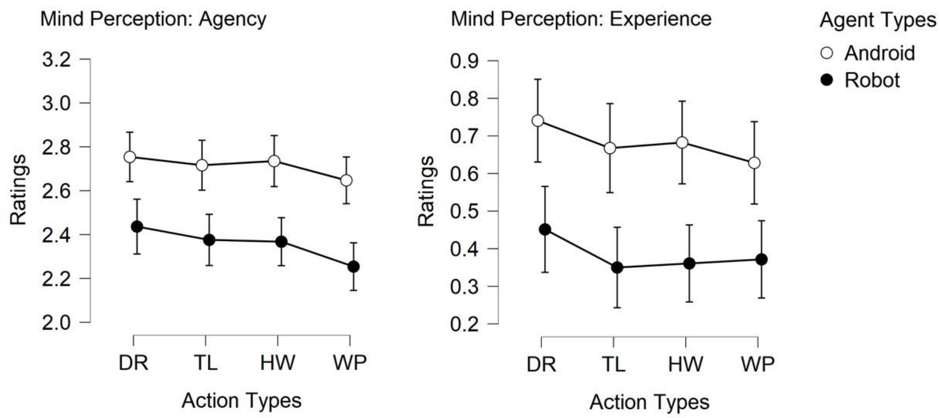

Figure 3.4: **Explicit mind perception results depending on actions and agents.** The robot agent was rated significantly lower than the android agent in both dimensions.

3.2.3 Action Type & Agent Type Interaction in Explicit Mind Perception

For the Agency dimension, Mauchly's test indicated that the assumption of sphericity had been violated (χ^2 (5) = 20.747, p <.001), therefore appropriate corrections were made using Greenhouse-Geisser correction. There was no interaction of agent and action (F (3, 2.793) = 0.527, p >.05, η^2 = 6.297e-4).

For the Experience dimension, Mauchly's test indicated that the assumption of sphericity had been violated (χ^2 (5) = 21.677, p <.001), therefore appropriate corrections were made using Greenhouse-Geisser correction. There was no interaction of agent and action (F (3, 2.781) = 0.595, p >.05, η^2 = 6.326e-4).

3.2.4 Action Type & Implicit Mind Perception

For the Agency dimension, Mauchly's test indicated that the assumption of sphericity had been violated (χ^2 (5) = 14.299, p <.05), therefore appropriate corrections were made using Greenhouse-Geisser correction. The result showed that there was a main effect of the action type (F (3, 2.831) = 13.723, p <.001, η^2 = 0.034). Post-hoc tests (Bonferroni corrected) indicated that the drinking action's reaction time was significantly faster than verbal communication action reaction time (t = -5.760, p <.001, 95% CI [-0.106 -0.039]), and non-verbal communication action reaction time (t = -4.708, p <.001, 95% CI [-0.092 -0.026]). However, there was no significant difference between drinking and wiping actions' reaction time (t = -1.954, p >.05, 95% CI [-0.025 -0.058]). Also, the wiping action reaction time was significantly faster than verbal communication action reaction time (t = 3.806, p <.001, 95% CI [0.015 0.0.081]), and non-verbal communication reaction time (t = 2.754, p <.05, 95% CI [0.001 0.068]).

Table 3.5: Post Hoc Comparisons - Actions in Implicit MP - Agency

		Mean Difference	SE	t	Cohen's d	p_{bonf}
DR	TL	−0.072	0.013	−5.760	−0.438	< .001
	HW	−0.059	0.013	−4.708	−0.358	< .001
	WP	−0.025	0.013	−1.954	−0.149	0.308
TL	HW	0.013	0.013	1.053	0.080	1.000
	WP	0.048	0.013	3.806	0.289	< .001
HW	WP	0.035	0.013	2.754	0.209	0.037

* p < .05, *** p < .001

For the Experience dimension, it was found that there was a main effect of the action type (F (3, 522) = 2.914, p <.05, η^2 = 0.007). Post-hoc tests (Bonferroni corrected) indicated that the verbal communication action reaction time was significantly faster than wiping action reaction time (t = -2.722, p <.05, 95% CI [-0.062 -8.562e-4]). There was no significant difference between other actions' reaction times.

Table 3.6: Post Hoc Comparisons - Actions in Implicit MP - Experience

		Mean Difference	SE	t	Cohen's d	p_{bonf}
DR	TL	0.024	0.012	2.047	0.155	0.247
	HW	0.013	0.012	1.143	0.086	1.000
	WP	−0.008	0.012	−0.675	−0.051	1.000
TL	HW	−0.010	0.012	−0.904	−0.068	1.000
	WP	−0.032	0.012	−2.722	−0.206	0.040
HW	WP	−0.021	0.012	−1.818	−0.137	0.418

* p < .05

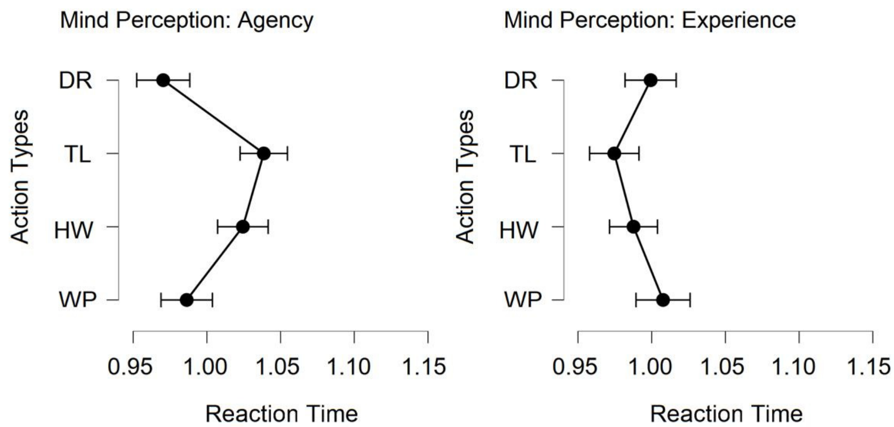

Figure 3.5: **Implicit mind perception results depending on actions.** Neutral action (WP) and biological action (DR) were rated significantly faster than communicative actions (TL and HW) in Agency dimension, yet communicative actions (TL and HW) were rated significantly faster than neutral action (WP) and biological action (DR) in Experience dimension. Details of 4 actions, DR: Drink, TL: Talk, HW: Handwave, WP: Wipe. The show on the x-axis of reaction time intervals is used to represent the direction of the flow of time.

3.2.5 Agent Type & Implicit Mind Perception

For the Agency dimension, it was found that there was no main effect of agent (F (1, 172) = 0.004, p >.05). For the Experience dimension, it was found that there was no main effect of agent (F (1, 174) = 3.460, p >.05).

3.2.6 Action Type & Agent Type Interaction in Implicit Mind Perception

For the Agency dimension, a two-way ANOVA revealed that there was a statistically significant interaction between the effects of action type and appearance (F (3, 2.933) = 2.784, p <.05, $\eta^2 = 0.006$). Post-hoc tests (Bonferroni corrected) indicated that while participants reacted wiping action and drinking action faster than non-verbal, verbal communication actions in Android appearance, while

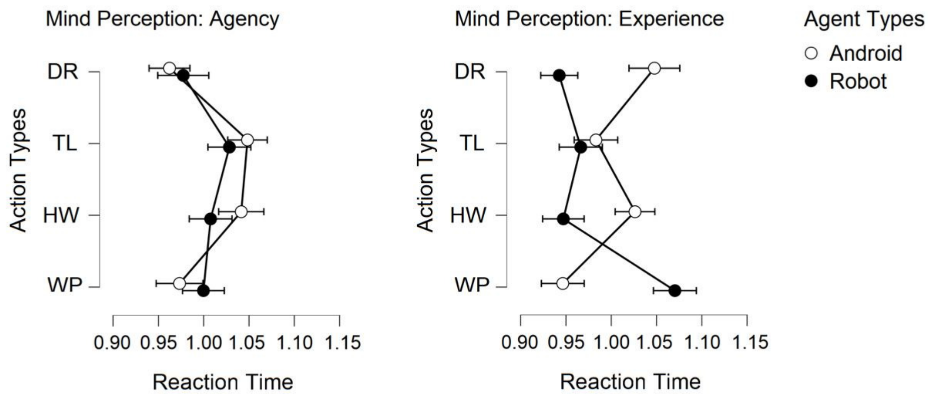

Figure 3.6: **Implicit mind perception results depending on actions and agents.** The difference between the agents did not show a significant result in both dimensions. However, an interaction effect has been observed between actions and agents. The participants responded faster to the android than to the robot in biological (DR) and neutral behavior (WP) while they responded faster to the robot than to the android in communicative behaviors (TL and HW) in Agency dimension. In the Experience dimension, participants responded slower to the android to robot in biological (DR) and communicative actions (TL and HW) than to neutral action (WP) while they responded slower to the robot to android in neutral action (WP) than to biological (DR) and communicative actions (TL and HW). Details of 4 actions, DR: Drink, TL: Talk, HW: Handwave, WP: Wipe. The show on the x-axis of reaction time intervals is used to represent the direction of the flow of time.

they reacted wiping and drinking actions slower than verbal, non-verbal actions in Robot appearance.

For the Experience dimension, a two-way ANOVA revealed that there was a statistically significant interaction between the effects of action type and appearance (F (3, 522) = 38.654, p <.001, η^2 = 0.085). Post-hoc tests (Bonferroni corrected) indicated that participants reacted wiping action faster than drinking, non-verbal, verbal communication actions in Android appearance, while they reacted wiping action slower than drinking, verbal, non-verbal actions in Robot appearance.

3.2.7 Individual Differences in Psychometrics

Psychometric measurement in individual differences scales was applied as written in the original articles of the inventories. If there is a Turkish validity adaptation of the inventories, the results are discussed in a comparative way.

3.2.7.1 Autism-Spectrum Questionnaire (ASQ) Factor Analysis and Validity Test

In order to test the validity of the ASQ, the factor structure of the scale was examined by performing explanatory factor analysis on the items that make up the scale. This analysis was obtained using data from 185 participants. From the explanatory factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient (.71) for the ASQ test and the significance level of the Bartlett sphericity test [χ^2 (1225) = 3097,167, p <.001] showed that the data were suitable for factor analysis. However, the five-factor structure of the ASQ was not observed in this study (see Table A.2 to examine the overall load and uniqueness of the factors). In the main component factor analysis, only one factor is defined; social skills. The Cronbach's α internal consistency coefficient of the scale is 0.72 [95% CI lower limit 0.66 - 95% CI upper limit 0.77].

The results of [60]'s translation of the ASQ test into Turkish; In the main component factor analysis, three factors are defined; communication/mind reading, details, social skills. Cronbach's α internal consistency coefficient of the scale was found to be 0.64.

3.2.7.2 Body Consciousness Test (BCT) Factor Analysis and Validity Test

In order to test the validity of the BCT, the factor structure of the scale was examined by performing explanatory factor analysis on the items that make up the scale. This analysis was obtained using data from 185 participants. From explanatory factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient (0.78) for the BCT test and the significance level of the Bartlett test of sphericity [χ^2 (105) = 729.285, p <.001] showed that the data were suitable for factor analysis. The three-factor nature of BCT was observed (see Table A.3 to examine the overall load and uniqueness of the factors). The Cronbach's α internal consistency coefficient of the scale is 0.79 [95% CI lower limit 0.74 - 95% CI upper limit 0.83].

3.2.7.3 Behavior Identification Form (BIF) Validity Test

In order to test the validity of the BIF, the overall high intentionality response rate for each question of the scale was examined by making descriptive statistics on the items that make up the scale [62] [63] This analysis was made using the data of 185 participants. The mean value of the number of bona fide responses for the test was 14.39 (out of 25) (SD = 0.45) (see Table A.4 to examine the overall intent perception distribution of actions).

3.2.7.4 Individual Differences in Anthropomorphism Questionnaire (IDAQ) Factor Analysis and Validity Test

In order to test the validity of the IDAQ, the factor structure of the scale was examined by performing explanatory factor analysis on the items that make up the scale. This analysis was obtained using data from 185 participants. From explanatory factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient (0.79) for the IDAQ test and the significance level of the Bartlett test of sphericity [χ^2 (435) = 1758.702, p <.001] showed that the data were suitable for factor analysis. The two-factor nature of IDAQ was observed (see Table A.5 to examine the overall load and uniqueness of the factors). The Cronbach's α internal consistency coefficient of the scale is 0.85 [95% CI lower limit 0.81 - 95% CI upper limit 0.88].

3.2.7.5 Interpersonal Reactivity Index (IRI) Factor Analysis and Validity Test

In order to test the validity of the IRI, the factor structure of the scale was examined by performing explanatory factor analysis on the items that make up the scale. This analysis was obtained using data from 185 participants. From explanatory factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient (0.80) for the IRI test and the significance level of the Bartlett test of sphericity [χ^2 (378) = 1672.143, p <.001] showed that the data were suitable for factor analysis. The four-factor nature of IRI was observed (see Table A.6 to examine the overall load and uniqueness of the factors). The Cronbach's α internal consistency coefficient of the scale is 0.80 [95% CI lower limit 0.75 - 95% CI upper limit 0.84].

3.2.7.6 Multidimensional Assessment of Interoceptive Awareness (MAIA-2) Factor Analysis and Validity Test

In order to test the validity of the MAIA-2, the factor structure of the scale was examined by performing explanatory factor analysis on the items that make up the scale. This analysis was obtained using data from 185 participants. From explanatory factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient (0.85) for the MAIA-2 test and the significance level of the Bartlett test of sphericity [χ^2 (666) = 3043.408, p <.001] showed that the data were suitable for factor analysis. The eight factor structure of MAIA-2 was observed in seven factor form (The first factor, "Notice", could not be observed). (see Table A.7 to examine the overall load and uniqueness of the factors). The Cronbach's α internal consistency coefficient of the scale is 0.87 [95% CI lower limit 0.84 - 95% CI upper limit 0.90]. The results of [70] translation of the MAIA-2 test into Turkish; In the main component factor analysis, six factors are defined; namely "Emotional Awareness", "Attention Regulation", "Body Listening", "Not-Distracting", "Trusting" and "Not-Worrying". Cronbach's α internal consistency coefficient of the scale was found to be 0.76.

3.2.7.7 Mechanical Self Dehumanization Scale (MSDS) Factor Analysis and Validity Test

In order to test the validity of the MSDS, the factor structure of the scale was examined by performing explanatory factor analysis of the main components on the items that make up the scale. This analysis was obtained using data from 185 participants. From the explanatory factor analysis, Kaiser-Meyer-Olkin (KMO) coefficient (0.69) for MSDS test and significance level of Bartlett test of sphericity [χ^2 (78) = 386,517, p <.001] showed that the data were suitable for factor analysis. However, the single factor structure of the MSDS was not observed in this study (see Table A.8 to examine the overall load and uniqueness of the factors). The Cronbach's α internal consistency coefficient of the scale is 0.65 [95% CI lower limit 0.57 - 95% CI upper limit 0.72].

3.2.7.8 Negative Attitudes Towards Robots Scale (NARS) Factor Analysis and Validity Test

In order to test the validity of the NARS, the factor structure of the scale was examined by performing explanatory factor analysis on the items that make up the scale. This analysis was obtained using data from 185 participants. From explanatory factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient (0.85) for the NARS test and the significance level of the Bartlett test of sphericity [χ^2 (91) = 1175.952, p <.001] showed that the data were suitable for factor analysis. The three-factor nature of NARS was observed (see Table A.9 to examine the overall load and uniqueness of the factors). The Cronbach's α internal consistency coefficient of the scale is 0.68 [95% CI lower limit 0.61 - 95% CI upper limit 0.73].

3.2.7.9 Positive and Negative Affect Scale (PANAS) Validity Test

In order to test the validity of the PANAS, the negative relationship between each subgroup (positive and negative affect groups) of the scale was examined [75] [76].

his analysis was performed using data from 185 participants. Negative significant correlation was observed between groups for the test (r = -0.260, $p < .05$) (see Table A.10 to review the overall accuracy distribution of the questions).

3.2.7.10 Reading Mind in Eyes Test (RMET) Validity Test

In order to test the validity of the RMET, the overall correct answer rate for each question of the scale was examined by making descriptive statistics on the items that make up the scale [77] [78]. This analysis was performed using data from 185 participants. The mean value of the number of correct answers for the test is 23.97 (out of 32) (SD = 0.41) (see Table A.11 to review the overall accuracy distribution of the questions). [78] correct answer mean values in the test were 24.46.

3.2.7.11 UCLA Loneliness Scale-3 (ULS-20) Factor Analysis and Validity Test

In order to test the validity of the ULS-20, the factor structure of the scale was examined by performing explanatory factor analysis on the items that make up the scale. This analysis was obtained using data from 185 participants. From explanatory factor analysis, the Kaiser-Meyer-Olkin (KMO) coefficient (0.92) for the ULS-20 test and the significance level of the Bartlett test of sphericity [χ^2 (190) = 1845.567, $p < .001$] showed that the data were suitable for factor analysis. The single-factor nature of ULS-20 was observed (see Table A.12 to examine the overall load and uniqueness of the factors). The Cronbach's α internal consistency coefficient of the scale is 0.90 [95% CI lower limit 0.88 - 95% CI upper limit 0.92].

The results of [80]'s translation of the ULS-20 test into Turkish; In the main component factor analysis, one factor is defined. Cronbach's α internal consistency coefficient of the scale was found to be 0.86.

3.2.8 Individual Differences Mind Perception

First, correlation analysis was performed for all dimensions of mind perception (Agency & Experience) and measurement levels (Explicit Implicit) separately. Later on a multiple linear regression was calculated to predict Agency and Experience and explicit and implicit mind perception.

3.2.8.1 Individual Differences & Explicit Mind Perception in Action Type

i. Drinking Action in Agency

The variables the Agency dimension in drinking action loneliness and intentionality in action were found to be strongly correlated, respectively r(183) = .21, p <.05; r(183) = -.22, p <.05.

For the Agency dimension in drinking action, a significant regression equation was found (F(2, 100) = 4.663, p <.05), with an R^2 of .085. Participants' predicted drinking action is equal to 2.593 + 0.20 (UCLA) - 0.21 (BIF) where UCLA is measured as loneliness and BIF is measured as intentionality in actions. Participants' drinking action's mind perception rates increased 0.20 for each perceived loneliness and decreased 0.21 for each perceived high intention in action. Loneliness and intentionality in actions were significant predictors of drinking action in mind perception of Agency.

ii. Talking Action in Agency

The variables the Agency dimension in talking action intentionality in action were found to be strongly correlated, r(183) = -.22, p <.05.

For the Agency dimension in talking action, a significant regression equation was found (F(1, 101) = 5.071, p <.05), with an R^2 of .048. Participants' predicted talking action is equal to 3.358 - 0.22 (BIF), where BIF is measured as intentionality in actions. Participants' talking action's mind perception rates decreased 0.22 for each perceived high intention in action. Intentionality was significant predictors of talking action in mind perception of Agency.

iii. Handwaving Action in Agency The variables the Agency dimension in hand waving action loneliness and intentionality in action were found to be strongly correlated, respectively r(183) = .21, $p < .05$; r(183) = -.25, $p < .05$.

For the Agency dimension in hand waving action, a significant regression equation was found ($F(2, 100) = 5.605$, $p < .01$), with an R^2 of .101. Participants' predicted hand waving action is equal to 2.683 + 0.20 (UCLA) - 0.24 (BIF) where UCLA is measured as loneliness and BIF is measured as intentionality in actions. Participants' hand waving action's mind perception rates increased 0.20 for each perceived loneliness and decreased 0.24 for each perceived high intention in action. Loneliness and intentionality in actions were significant predictors of hand waving action in mind perception of Agency.

iv. Wiping Action in Agency

The variables the Agency dimension in wiping action loneliness, body consciousness and intentionality in action were found to be strongly correlated, respectively r(183) = .21, $p < .05$; r(183) = -.25, $p < .05$; r(183) = -.23, $p < .05$.

For the Agency dimension in wiping action, a significant regression equation was found ($F(3, 99) = 4.279$, $p < .01$), with an R^2 of .115. Participants' predicted wiping action is equal to 3.457 + 0.18 (UCLA) where UCLA is measured as loneliness. Participants' wiping action's mind perception rates increased 0.18 for each perceived loneliness. Loneliness was significant predictors of wiping action in mind perception. Body consciousness and intentionality did not predict the wiping action in mind perception of Agency.

v. Drinking Action in Experience

The variables the Experience dimension in drinking action theory of mind, body consciousness and intentionality in action were found to be strongly correlated, respectively r(183) = -.28, $p < .01$; r(183) = -.24, $p < .05$, r(183) = -.31, $p < .01$.

For the Experience dimension in drinking action, a significant regression equation was found (F(3, 99) = 7.296, $p < .001$), with an R^2 of .181. Participants' predicted drinking action is equal to 3.995 - 0.27 (RMET) - 0.26 (BIF) where RMET is measured as theory of mind and BIF is measured as intentionality in actions. Participants' drinking action's mind perception rates decreased 0.27 for each perceived theory of mind and 0.26 for each perceived high intention in action. Theory of mind and intentionality in actions were significant predictors of drinking action in mind perception. Body consciousness did not predict the drinking action in mind perception of Experience.

vi. Talking Action in Experience

The variables the Experience dimension in talking action theory of mind, body consciousness and intentionality in action were found to be strongly correlated, respectively r(183) = -.23, $p < .05$; r(183) = -.22, $p < .05$, r(183) = -.30, $p < .01$.

For the Experience dimension in talking action, a significant regression equation was found (F(3, 99) = 5.766, $p < .01$), with an R^2 of .149. Participants' predicted talking action is equal to 3.120 - 0.22 (RMET) - 0.25 (BIF) where RMET is measured as theory of mind and BIF is measured as intentionality in actions. Participants' talking action's mind perception rates decreased 0.22 for each perceived theory of mind and 0.25 for each perceived high intention in action. Theory of mind and intentionality in actions were significant predictors of talking action in mind perception. Body consciousness did not predict the talking action in mind perception of Experience.

vii. Handwaving Action in Experience

The variables the Experience dimension in hand waving action theory of mind, positive mood, body consciousness and intentionality in action were found to be strongly correlated, respectively r(183) = -.21, $p < .05$; r(183) = -.21, $p < .05$;

r(183) = -.29, p <.01; r(183) = -.31, p <.01.

For the Experience dimension in hand waving action, a significant regression equation was found (F(4, 98) = 4.964, p <.01), with an R^2 of .168. Participants' predicted hand waving action is equal to 3.319 - 0.20 (RMET) - 0.22 (BIF) where RMET is measured as theory of mind and BIF is measured as intentionality in actions. Participants' hand waving action's mind perception rates decreased 0.20 for each perceived theory of mind and 0.22 for each perceived high intention in action. Theory of mind and intentionality in actions were significant predictors of talking action in mind perception. Positive mood and body consciousness did not predict the hand waving action in mind perception of Experience.

viii. Wiping Action in Experience

The variables the Experience dimension in wiping action theory of mind, body consciousness and intentionality in action were found to be strongly correlated, respectively r(183) = -.29, p <.01; r(183) = -.23, p <.05, r(183) = -.25, p <.01.

For the Experience dimension in wiping action, a significant regression equation was found (F(3, 99) = 6.169, p <.001), with an R^2 of .157. Participants' predicted wiping action is equal to 3.278 - 0.27 (RMET) - 0.20 (BIF) where RMET is measured as theory of mind and BIF is measured as intentionality in actions. Participants' wiping action's mind perception rates decreased 0.27 for each perceived theory of mind and 0.20 for each perceived high intention in action. Theory of mind and intentionality in actions were significant predictors of talking action in mind perception. Body consciousness did not predict the wiping action in mind perception of Experience.

3.2.8.2 Individual Differences & Explicit Mind Perception in Agent Type

i. Android Appearance in Agency

The variables the Agency dimension in android appearance intentionality in action was found to be strongly correlated, r(183) = -.26, p <.01.

For the Agency dimension in android appearance, a significant regression equation was found (F(1, 101) = 7.482, p <.01), with an R^2 of .069. Participants' predicted android appearance is equal to 3.811 - 0.26 (BIF) where BIF is measured as intentionality in actions. Participants' android appearance's mind perception rates decreased 0.26 for each perceived high intention in action. Intentionality was significant predictors of android appearance in mind perception.

ii. Robot Appearance in Agency

The variables the Agency dimension in robot appearance loneliness and body consciousness were found to be strongly correlated, respectively r(183) = .24, p <.05; r(183) = -.20, p <.05.

For the Agency dimension in robot appearance, a significant regression equation was found (F(2, 100) = 4.707, p <.05), with an R^2 of .086. Participants' predicted robot appearance is equal to 2.579 + 0.22 (UCLA) where UCLA is measured as loneliness. Participants' robot appearance's mind perception rates increased 0.22 for each perceived loneliness. Loneliness was significant predictors of robot appearance in mind perception.

iii. Android Appearance in Experience

The variables the Experience dimension in android appearance positive mood, body consciousness and intentionality in action were found to be strongly correlated, respectively r(183) = -.20, p <.05; r(183) = -.23, p <.01; r(183) = -.34, p <.001.

For the Experience dimension in android appearance, a significant regression equation was found (F(3, 99) = 4.839, p <.01), with an R^2 of .128. Participants' predicted android appearance is equal to 2.343 - 0.28 (BIF) where BIF is measured as intentionality in actions. Participants' android appearance's mind perception rates decreased 0.28 for each perceived high intention in action. Intentionality was significant predictors of android appearance in mind perception. Positive mood and body consciousness did not predict the android appearance in mind perception of Experience.

iv. Robot Appearance in Experience

The variables the Experience dimension in robot appearance theory of mind, body consciousness and intentionality in action were found to be strongly correlated, respectively r(183) = -.32, $p < .001$; r(183) = -.24, $p < .05$; r(183) = -.21, $p < .05$.

For the Experience dimension in robot appearance, a significant regression equation was found (F(3, 99) = 6.653, $p < .001$), with an R^2 of .168. Participants' predicted robot appearance is equal to 3.167 - 0.31 (RMET) where RMET is measured as theory of mind. Participants' robot appearance's mind perception rates decreased 0.31 for each perceived theory of mind. Theory of mind was significant predictors of robot appearance in mind perception. Body consciousness and intentionality did not predict the robot appearance in mind perception of Experience.

3.2.8.3 Individual Differences & Implicit Mind Perception in Action Type

i. Drinking Action in Agency

There was no variable showing any correlation for Agency dimension in drinking action. Therefore, a regression analysis was not conducted.

i. Talking Action in Agency

The variables the Agency dimension in talking action intentionality in action were found to be strongly correlated, r(183) = .26, $p < .01$.

For the Agency dimension in talking action, a significant regression equation was found ($F(1, 99) = 7.272$, $p < .01$), with an R^2 of .068. Participants' predicted talking action is equal to 0.903 + 0.26 (BIF), where BIF is measured as intentionality in actions. Participants' talking action's mind perception rates increased 0.26 for each perceived high intention in action. Intentionality was significant predictors of talking action in mind perception of Agency.

i. Handwaving Action in Agency

There was no variable showing any correlation for Agency dimension in hand waving action. Therefore, a regression analysis was not conducted.

i. Wiping Action in Agency

There was no variable showing any correlation for Agency dimension in wiping action. Therefore, a regression analysis was not conducted.

v. Drinking Action in Experience

The variables the Experience dimension in drinking action negative mood was found to be strongly correlated, $r(183) = .20$, $p < .05$.

For the Experience dimension in drinking action, a significant regression equation was found ($F(1, 97) = 4.175$, $p < .05$), with an R^2 of .041. Participants' predicted drinking action is equal to 0.854 + 0.20 (NEGEMO) where NEGEMO is measured as negative mood. Participants' drinking action's mind perception rates increased 0.20 for each perceived negative emotion. Negative mood was significant predictors of drinking action in mind perception.

vi. Talking Action in Experience

There was no variable showing any correlation for Experience dimension in talking action. Therefore, a regression analysis was not conducted.

vii. Handwaving Action in Experience

The variables the Experience dimension in hand waving action anthropomorphism was found to be strongly correlated, r(183) = -.23, p <.05.

For the Experience dimension in hand waving action, a significant regression equation was found (F(1, 100) = 5.747, p <.05), with an R^2 of .054. Participants' predicted hand waving action is equal to 1.102 + 0.23 (IDAQ) where IDAQ is measured as anthropomorphism. Participants' hand waving action's mind perception rates increased 0.23 for each perceived anthropomorphism. Anthropomorphism was significant predictors of hand waving action in mind perception.

viii. Wiping Action in Experience

The variables the Experience dimension in wiping action negative mood was found to be strongly correlated, r(183) = .20, p <.05.

For the Experience dimension in wiping action, a significant regression equation was found (F(1, 100) = 4.028, p <.05), with an R^2 of .039. Participants' predicted wiping action is equal to 0.870 + 0.20 (NEGEMO) where NEGEMO is measured as negative mood. Participants' wiping action's mind perception rates increased 0.20 for each perceived negative emotion. Negative mood was significant predictors of wiping action in mind perception.

3.2.8.4 Individual Differences & Implicit Mind Perception in Agent Type

i. Android Appearance in Agency

There was no variable showing any correlation for Agency dimension in the android appearance. Therefore, a regression analysis was not conducted.

ii. Robot Appearance in Agency

The variables the Agency dimension in robot appearance intentionality in action was found to be strongly correlated, r(183) = .21, p <.05.

For the Agency dimension in robot appearance, a significant regression equation was found ($F(1, 100) = 4.487$, $p < .05$), with an R^2 of .043. Participants' predicted robot appearance is equal to 0.927 + 0.21 (BIF) where BIF is measured as intentionality in action. Participants' robot appearance's mind perception rates increased 0.21 for each perceived high intention in action. Intentionality was significant predictors of robot appearance in mind perception.

iii. Android Appearance in Experience

There was no variable showing any correlation for Experience dimension in the android appearance. Therefore, a regression analysis was not conducted.

iii. Robot Appearance in Experience

There was no variable showing any correlation for Experience dimension in the robot appearance. Therefore, a regression analysis was not conducted.

3.3 Intermediate Discussion

As a result of this study, the effects of robot actions and appearances on mind perception were measured separately using Explicit and Implicit methods. In the study, as in the previous study, both explicit (rating) measurement and implicit (reaction time) measurement were performed based on actions in 4 different spectrums and 2 robot appearances. The Mind Perception Questionnaire, which was adapted into Turkish in the previous study, was used in the explicit measurement. Accordingly, each participant made a rating based on each behavior and appearance, based on the valid 4 Agency items and 4 Experience items. In Implicit measurement, using the reaction time paradigm, each behavior and appearance was measured by people reacting. Accordingly, when categorizing the participant Agency and Experience dimensions, which see the behavior and appearance of the robots as primary each time, the extent to which the primer could delay this reaction time was measured. The results looked at whether the mind's perception can be measured both explicitly and implicitly. Here, all results for each measurement method were compared within the design. 2 robot appearances were examined as a group. With repeated measures of ANOVA, the effects of 2 measurement methods on 2 dimensions of mind perception of 4 actions in 2 appearances were examined.

In this study, the individual differences that predict the results of explicit and implicit mind perception were comprehensively examined. The 11 scales used in the study, ASQ, BCT, BIF, IDAQ, IRI, MAIA-2, MSDS, NARS, PANAS, RMET, and ULS-20, measure autism spectrum, body awareness, the intentionality of behavior, anthropomorphism, empathy, common sense, dehumanization, negative attitudes towards robots, positive and negative moods, theory of mind, and loneliness, respectively. It was measured whether all the individual differences mentioned here predicted 4 different actions and 2 different appearances in 2 different methods through 2-dimensional mind perception. Exploratory factor analysis (EFA) and Confirmatory factor analysis (CFA) were applied for each individual difference scale (Exploratory factor analysis (EFA) for newly tested scales; Confirmatory factor analysis (CFA) for scales validated in the literature). In addition, Cronbach's α values were extracted for each test. The process of predicting individual differences between 2 appearances and 4 actions in 2 different measurements over 2 dimensional mind perception was examined through multiple linear regression.

Looking at the modulation of agent actions on explicit mind perception for the Agency dimension, performing a neutral action led to less mind perception than a biological action. In addition, neutral behavior almost significantly measured less mind perception than non-verbal communication action. However, no such result was observed between a verbal communicative action and a neutral action. When we examine the results, biological action was more attributable to the mind than neutral action. Likewise, the gesture of waving, which is non-verbal but a communication action, has received almost more mind attribution than a neutral action. For the Experience dimension, performing a neutral action led to less mind perception than a biological action. However, no such result was observed between communicative actions and a neutral action. In the light of these results, robots that perform biological action receive more mind attribution than robots that perform neutral action in the Experience dimension. There is no difference between neutral action and communication actions.

Looking at the modulation of agent appearances on explicit mind perception for the Agency dimension, the mechanical robot appearance receives less mind attribution than the android robot appearance. Likewise, in the Experience dimension, the mechanical robot appearance receives less mind attribution than the android robot appearance. This result showed parallelism with the literature [30]. In this case, the more human-like appearance of the robot creates more mental attribution in people. Note that we did not find an effect of agent appearance in the first study. The main difference between this study and the first study was the experimental design. In the between-subject design (Study 1), each group of participants saw and rated only one agent, so there was nothing to compare; they basically compared the behaviors in the only view they saw. However, in the within-subject design, the appearance affected the mind perception parallel to the literature. As stated before, when people have the chance to compare two different appearances, like in the case of actions, a more human-like appearance creates a more explicit mind perception, such as more human-like behaviors. Finally, no interaction was observed for Agency and Experience for explicit mind perception.

Looking at the modulation of agent actions on implicit mind perception for the Agency dimension, interestingly, the response to biological action and neutral action was faster than communication actions. There was no difference between the communication actions. When the Experience dimension was examined, the verbal communication action received a faster response than the neutral behavior. Apart from this, no action showed a significant difference in reaction time in the Experience dimension. When the results were evaluated, the actions were not evaluated as biological and neutral as implicit measurements but as communicative behaviors or non-communicative actions. Socialization can be observed as a basis for implicit results. When we consider the situations that cause mental perception, Social bonding is one of the causes in schema [2]. Therefore, it can be considered reasonable that an action based on socialization creates a mind perception in implicit steps. In this context, even though drinking water is a biological behavior, it does not require socialization and does not need a second individual, just like neutral behavior. In mind perception, communication behaviors require sociability and can affect reaction time in bottom-up processing. Thus, communication behaviors received a delayed response for the Agency dimension. As expected, in the Experience dimension, the act of communication received a faster response, which indicates that it is more easily attributed to the mind.

In this study, looking at the modulation of agent appearances on implicit mind perception, it was seen that the two appearances did not affect the dimensions of mind perception. Although this result seems interesting, [82] showed results that can be obtained from a similar insight. The study was conducted with EEG, the appearances of robot, android, and human were used, and the MNS activation of the participants was examined while each agent performed the same behavior. Although the participants in the experimental results rate the android much more similar to the human, in the EEG results, the only agent that created the MNS module was the human. In other words, although the human and android appearance are the same ratings and perform the actions in the same way, the android and the robot did not create an activation on the MNS. From this perspective, although the android and the robot seem different when considered normatively, they are in the same category in mental activation. The interaction between action and appearance has been found in both dimensions of implicit mind perception. For the Agency dimension, interestingly, individuals respond faster to neutral and biological actions than the communication actions in the spectrum in android appearance, while in robot appearance, they respond faster to communication actions than the neutral and biological actions. For the Experience dimension, individuals respond faster to neutral action than the other 3 actions in the spectrum in android appearance, while in robot appearance, they respond faster to biological behavior than the other 3 actions. Although the reason for this interaction was not fully observed in this study, it can be said that the appearance has an implicit effect on the action reaction type. Even there is not significant difference in appearance type in implicit measurement, when the topic comes to the interaction the appearance of the robots modulates the response time to actions. In future studies, why the appearance provides action modulation should be visited in detail.

According to the validity and factor analysis on individual differences, although the ASQ (autism spectrum) and MSDS (dehumanization) Cronbach's α values were sufficient, they were not included in the tests because they could not create the necessary factor loading. In both tests, factor loadings statistically were not consistently filled; therefore, it was decided that these two tests should not be included. Consequently, 9 different scales were used in the analysis to measure individual differences. In the multiple linear regression process, for the Agency dimension in explicit mind perception, it has been found that the perception of loneliness and the intention of action predict biological and non-verbal behavior. People who felt more alone and read behavior with low-level intent attributed more minds to biological and non-verbal behavior. Also, it has been found that the intention of action predicts verbal communication behavior. People who read behavior with low-level intent attributed more minds to verbal communication behavior. Lastly, it has been found that the perception of loneliness predicts neutral behavior. People who felt more alone attributed more minds to neutral behavior. When the results were evaluated in this context, it was seen that individuals, who felt more alone and approached the actions superficially (low level), attributed minds to robots. It is observed in the literature that the perception of loneliness attributes more minds to robots [41]. Likewise, the perception of loneliness predicts almost every behavior. In the novel part of the study, it was seen that people who generally evaluate actions superficially attribute more minds to robots that perform biological and communication actions.

For the Experience dimension in explicit mind perception, it was found that the theory of mind and the intention of action predicted all behaviors. For the Experience dimension, individuals with the high theory of mind perceived lower mind perception no matter what behavior the robots perform, and people who read behavior with low-level intent attributed more minds to all behavior performed by robots. Considering the results, although the literature suggests that the mind perception and the theory of mind work in the same brain region, our study found that people with the high theory of mind levels scored low in robots' mind perception. A main reason why the results look like this may be that there are studies showing that the RMET scale basically measures emotion reading rather than theory of mind [83] Since an inanimate being is already used as the agent, it may have created a higher awareness that robots are more likely to be inanimate for people with a high RMET score in emotion measurement; therefore, people with high RMET scores may have lowered the mind perception scores of the robots. Although RMET is still a valid test in the literature for the measurement of theory of mind, the relationship with robots may also reveal different aspects. As discussed in [84] article, to read mental capacities and to observe a more robust theory of mind and mind perception relationship in robots different tests can be applied (e.g., Detection of Faux Pas).

From the appearance type, in the Agency dimension in explicit mind perception, it has been found that the intention of action was found to predict android appearance; the perception of loneliness and body consciousness was found to predict robot appearance. People who read behavior with low-level intent attributed more minds to android appearance; people who felt more alone and less aware of their body sensations attributed more minds to robot appearance. While it may seem interesting that less body-sensing people attribute more minds to robots, it produces a consistent result [34]. As body perception weakens, the sense of vitality may be neutralized, which may have led to attributing minds to robots. In the Experience dimension, it has been found that the intention of action was found to predict android appearance; the theory of mind was found to predict robot appearance. People who read behavior with low-level intent attributed more minds to android appearance; people with a high theory of mind attributed less minds to robot appearance.

In the multiple linear regression process, for the Agency dimension in implicit mind perception, it has been found that the intention of action predicts verbal behavior. People who read behavior with high-level intent attributed less minds to verbal communication behavior. In the Agency dimension in implicit mind perception, an individual difference that predicts other behaviors was not detected. When we look at the Experience dimension, it has been found that the negative mood predicts biological and neutral behavior; anthropomorphism predicts non-verbal behavior. People who felt in negative moods attributed less minds to biological and neutral behaviors. Also, people who anthropomorphize more attributed more minds to non-verbal actions performed by robots. Feeling negative (due to the nature of the PANAS scale) has been paired with the neurotic personality by [75]. Therefore, it is an expected result that neuroticism creates less mind perception. Because it has been discussed in the literature that more neurotic people are prone to anxiety, and in this case, they do not, or less attribute their mind to the object in front of them [9] [37]. Due to the nature of anthropomorphism, attributing a mind to a social behavior has produced a very consistent result.

Lastly, from the appearance type, in the Agency dimension in implicit mind perception, it has been found that the intention of action was found to predict robot appearance but there is no prediction for android appearance. Similarly, in terms of Experience, any individual differences were not predicted for either android or robot appearance.

Chapter 4

General Discussion

In this thesis, we investigated the influence of robot actions on mind perception. In deep dive, the measurability of robot behaviors and appearance in mind perception with two different methods (explicit and implicit) were investigated. In addition, individual differences that can predict explicit and implicit results were examined. In the first study, while making the measurements, the explicit method was used, and ratings were taken. In the second study, as in the first study, ratings were taken as the explicit measurement method; in addition, the response time paradigm was used as an implicit measurement method. In the second study, individual difference results were also obtained for each participant and whether it predicted explicit & implicit results.

As the results showed, the robot actions differed in mind perception when viewed from the biological to non-biological. The main differentiation is that individuals attribute less mind to non-biological behavior (neutral action) than other behaviors (biological and communication actions). This result applies to robots that appear in any view. Upon further examination, neutral behavior was found to be significantly different from every other behavior for the Agency dimension. For the Experience dimension, a significant difference is observed between neutral behavior and biological behavior. When these results are evaluated, what should be considered when making high-tech robots; it is not important that the robot that will interact with humans performs only one action. Which action the robot performs makes a difference in terms of the human interacting. The important point here is that if we think that robots will be very involved in people's social life in the future, it has been shown how performing humanoid actions will make a difference when interacting with robots.

Other findings are that robot behavior, when combined with appearance, show results consistent with the literature. In a multidimensional perception system, it has been shown how appearance can affect interaction as appearance becomes human-like mind attribution is increased. It has been shown in the literature that predictability increases mind perception [28]. What we're also showing here is that with a more human-like appearance and behavior, the predictability of robots increases, which automatically leads to more mind perception. In addition, in this thesis, it has been checked whether the perception of the mind can be measured by the reaction process by using a new and different method. It has been found that the paradigm of measuring by reaction time can apply mind perception in robots.

In particular, this study showed how the reaction time paradigm can measure response time to different actions performed by robots. According to the results, measurement with the response time paradigm could not catch a difference in terms of different appearances shown by robots. When the robot behaviors are examined in detail and measured with the response time paradigm in perceiving robots' behavior as implicit, it would be better to evaluate actions as communicative and non-communicative rather than from biological to neutral. The results show that people's reaction time score responds to communication behaviors as a group and differently from other behaviors. What we found most important supporting these results was that verbal and non-verbal communication behavior was responded to almost the same in both dimensions, while biological and neutral behavior was responded to in the same way in both dimensions. In addition, our important finding is that verbal communication is the behavior that responds most quickly in the Experience dimension; one of the most important reasons while perceiving the mind perception of people is the tendency to establish social bonds.

A major contribution of this thesis comes from the use of the implicit measurement method in the measurement of mind perception. When we look at the mind perception literature today, most of these studies were carried out with explicit measurement methods. While this gives us much insight into the interaction of humans with robots, it leads us to miss the inner structure of the mental process. Beyond the decision part of the interaction, we capture the belief and process with implicit measurement methods. As this study shows, it provides new indicators as well as what explicit measurements show and actually produces indicators parallel to the causes that can form the skeleton of mind perception. As implicit measurement shows us, the fact that the actions of robots can not be tested on mind perception only in explicit measurements and showing how robot behaviors affect mind perception in implicit measurement methods has been a great new addition to the literature.

Another important part of the study is to show how individual differences modulate mind perception. The results demonstrate that the intention of the behavior predicted the scores in almost all of the explicit results. The basic pattern here is that when individuals define the action in the greater low-level intent (c. Behavior Identification Form (BIF) in 3.1.2 Individual Differences Parameters for an example), the more they impart mind perception to robots. As the main reason, the capability to realize the behavior itself rather than being alive to show this behavior may have created the perception of mind in these people. Another result of individual differences is that the perception of loneliness predicts especially for Agency dimension scores. Especially considering that the Agency dimension is evaluated through ability, lonely people may be more inclined towards a robot that can be a company to do things with themselves rather than to feel something together. This is an important issue because this may create a positive interaction if it is thought that robots will enter their lives more prominently in the future, especially in old age or single individuals [29] [85].

When we look at the implicit results, the most important finding in the individual differences that predict the delay of the reaction time, it was seen that the individuals in the negative mood reacted especially later in the biological and neutral behaviors. It can be thought that the main finding here is that people in a negative mood are more prone to anxiety so they may have been disturbed by non-communicative actions for the Experience dimension. The results did not show a clear pattern of individual differences between communicative and non-communicative actions. This phenomenon needs to be further explored in the future. Another study in which robots perform communicative behaviors and how individual differences can predict implicit mind perception scores may be good for enlightening the details of today's result.

One of the main limitations of this study is that the ecological study was not carried out with a real robot. Although today's Human-Robot Interaction studies mostly use robot pictures or videos as visual stimuli, the presence of people in a physical environment with the robot and the physical observation of it may differ in terms of results. It is essential to perform these tests again in the physical environment, especially when some results do not form a pattern. As another limitation, the effect of conducting the study online is not fully known. Here, it has not been fully controlled how individuals filled the scales, especially individual differences tests. Although the results showed significant patterns, it should be checked and re-tested that individuals fill these scales more systematically. Another concern with individual differences is not knowing whether the greater impact of negative outcomes impacts negative mood, loneliness, or a more superficial perception of behavior due to the COVID pandemic. For this reason, it is essential to repeat the tests in case the effect of the pandemic has passed. This will also provide an important and reliable output to create within a multidimensional structure in terms of the repeatability of the tests.

Chapter 5

Conclusion

As the output of this thesis, when the behavior of the robots was controlled with the explicit measurement technique, in both dimensions it was observed that gradually the biological behaviors (drinking) and communication behaviors (talking hand waving) attributed more than the neutral behavior (wiping); with the implicit measurement technique, in agency dimension, communication behaviors (talking hand waving) were reacted to a slower than biological (drinking) and neutral (wiping) behavior. In the experience dimension, communication behaviors were reacted to faster than biological and neutral behavior in terms of mind perception. While the effect of robot appearance is important in explicit measurement, it does not make a difference for implicit measurement. Individual differences differ in individuals' attributing minds to robots. While the sense of intention of action, theory of mind and feeling of loneliness are core for explicit measurements, negative mood is the basis for implicit measurements. With this study, the effect of different individual differences on creating a mind perception in interaction with robots has been demonstrated.

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Appendix A

Factor Loads of Individual Differences Measurements

Table A.1: Factor Loadings for Turkish Mind Perception Questionnaire

	Experience	Agency	Uniqueness
Pleasure (E)	0.929		0.220
Pain (E)	0.864		0.277
Hunger (E)	0.814		0.423
Fear (E)	0.742		0.464
Emotion Recognition (A)	0.859		0.203
Thought (A)	0.569		0.627
Self (A)		0.699	0.289
Self control (A)		0.628	0.346
Memory (A)		0.621	0.701
Morality (A)		0.530	0.669
Consciousness (E)		0.918	0.321
Personality (E)		0.668	0.291

Table A.2: Factor Loadings for ASQ

	A-Soc	B-Att	C-Det	D-Cmm	E-Ima	Uniqueness
A1	0.401					0.840
A11	0.695					0.419
A13	0.511					0.699
A15	0.498					0.744
A22	0.556					0.523
A44	-0.458					0.604
A47	0.687					0.453
E17	0.793					0.430
E38	0.724					0.342
B32		0.410				0.789
B37		0.414				0.688
A36		0.572				0.612
A45		-0.599				0.650
A48		0.656				0.577
E27		0.571				0.717
E31		0.563				0.655
B2			0.456			0.759
B4			0.546			0.713
B16			0.465			0.788
B46			0.446			0.597
D12			0.413			0.644
D23			0.415			0.803
E39			0.526			0.719
D30				-0.458		0.705
C8				0.428		0.654
C40				0.431		0.781
E18				0.420		0.644
C41					0.484	0.657
D6					0.598	0.605
D9					0.539	0.727
D29					0.444	0.801
D49					0.495	0.691

Note. A: Social Skills; B: Attention Shifting; C: Details; D: Communication; E: Imagination.

Table A.3: Factor Loadings for BCT

	PrBC	PuBC	BC	Uniqueness
A1	0.451			0.808
A2	0.447			0.713
A3	0.344			0.852
A4	0.533			0.728
A5	0.663			0.568
B6		0.681		0.588
B7		0.615		0.600
B8		0.559		0.673
B9		0.793		0.474
B10		0.327		0.806
B11		0.484		0.590
C12			0.611	0.629
C13			0.651	0.483
C14			0.924	0.260
C15			0.812	0.398

Note. PrBC: Private Body Consciousness; PuBC: Public Body Consciousness; BC: Body Competence.

Table A.4: Structural Matrix for BIF

Item	*Mean (M)*	*Std. Dev.*	Item	*Mean (M)*	*Std. Dev.*
1. Making a list	0.881	0.325	14. Climbing a tree	0.341	0.475
a. Geting organized*			a. Getting a good view*		
b. Writing things down			b. Holding on to branches		
2. Reading	0.854	0.354	15. Filling out a personality test	0.762	0.427
a. Following lines of print			a. Answering questions		
b. Gaining knowledge*			b. Revealing what you're like*		
3. Joining the army	0.427	0.496	16. Tooth brushing	0.816	0.388
a. Helping the nation's defense*			a. Preventing tooth decay*		
b. Signing up			b. Moving a brush around in one's mouth		
4. Washing clothes	0.584	0.493	17. Taking a test	0.341	0.475
a. Removing odors from clothes*			a. Answering questions		
b. Putting clothes into the machine			b. Showing one's knowledge*		
5. Picking an apple	0.319	0.467	18. Greeting someone	0.405	0.492
a. Getting something to eat*			a. Saying hello		
b. Pulling an apple off a branch			b. Showing friendliness*		
6. Chopping down a tree	0.368	0.483	19. Resisting temptation	0.427	0.496
a. Wielding an axe			a. Saying "no"		
b. Getting firewood*			b. Showing moral courage*		
7. Measuring a room for carpeting	0.427	0.496	20. Eating	0.914	0.282
a. Getting ready to remodel*			a. Getting nutrition*		
b. Using a yardstick			b. Chewing and swallowing		
8. Cleaning the house	0.389	0.489	21. Growing a garden	0.573	0.496
a. Showing one's cleanliness*			a. Planting seeds		
b. Vacuuming the floor			b. Getting fresh vegetables*		
9. Painting a room	0.541	0.5	22. Traveling by car	0.886	0.318
a. Applying brush strokes			a. Following a map		
b. Making the room look fresh*			b. Seeing countryside*		
10. Paying the rent	0.541	0.5	23. Having a cavity filled	0.481	0.501
a. Maintaining a place to live*			a. Protecting your teeth*		
b. Writing a check			b. Going to the dentist		
11. Caring for houseplants	0.232	0.424	24. Talking to a child	0.535	0.5
a. Watering plants			a. Teaching a child something*		
b. Making the room look nice*			b. Using simple words		
12. Locking a door	0.811	0.393	25. Pushing a doorbell	0.751	0.433
a. Putting a key in the lock			a. Moving a finger		
b. Securing the house*			b. Seeing if someone's home*		
13. Voting	0.784	0.413			
a. Influencing the election*					
b. Marking a ballot					

Note. M is proportion of higher-level responses.
"*" is higher-level alternative.

Table A.5: Factor Loadings for IDAQ

	Factor	Uniqueness
tmind	0.607	0.629
twill	0.636	0.622
tintent	0.655	0.599
tcons	0.621	0.622
temo	0.590	0.673
tdur		0.973
tuse		0.968
tgoodl		0.957
tact	0.471	0.793
tleth		0.921
amind	0.617	0.588
awill	0.429	0.738
aintent	0.597	0.647
acons	0.629	0.575
aemo	0.649	0.598
adur		0.914
ause		0.942
agoodl	0.529	0.738
aact	0.425	0.828
aleth		0.957
nmind	0.556	0.558
nwill	0.721	0.487
nintent	0.715	0.491
ncons	0.708	0.387
nemo	0.560	0.612
ndur	0.451	0.753
nuse		0.873
ngoodl	0.407	0.835
nact		0.715
nleth		0.912

Note. a: animal, n: nature, t: technology; mind: mind, will: free will, intent: intentions, cons: consciousness, emo: emotions, act: active, leth: lethargic, goodl: good looking, dur: durable, use: useful. The anthropomorphism items are mind, will, intent, cons, emo; whereas non-anthropomorphism items are act, leth, goodl, dur, use.

Table A.6: Factor Loadings for IRI

	PersonalA	PespectiveT	Fantasy	EmphaticT	Uniqueness
D6	0.869				0.324
D10	0.550				0.615
D13	0.621				0.625
D19	0.658				0.569
D24	0.750				0.467
D27	0.583				0.682
B20	0.449				0.619
C3		0.527			0.552
C8		0.824			0.462
C11		0.686			0.493
C21		0.629			0.665
C25		0.603			0.587
C28		0.782			0.423
A1			0.484		0.760
A5			0.778		0.349
A16			0.725		0.519
A23			0.660		0.431
A26			0.721		0.509
B2				0.434	0.734
B4				0.651	0.598
B9				0.469	0.749
B14				0.564	0.675
B18				0.459	0.853

Note. PersonalA: Personal Anxiety; PerspectiveT: Perspective Taking; Fantasy: Fantasy; EmphaticT: Emphatic Thought.

Table A.7: Factor Loadings for MAIA-2

	EA	AR	ND	NW	SR	T	BL	N	Uniqueness
E23	0.607								0.578
E24	0.697								0.474
E25	0.709								0.506
E26	0.793								0.379
E27	0.698								0.430
D16		0.433							0.618
D17		0.850							0.388
D19		0.780							0.368
D20		0.706							0.434
D21		0.774							0.375
B5			0.422						0.666
B6			0.664						0.555
B8			0.510						0.589
B9			0.803						0.351
B10			0.859						0.284
C11				0.555					0.694
C12				0.688					0.539
C13				0.412					0.714
C14				0.797					0.257
C15				0.537					0.667
F29					0.598				0.428
F30					0.648				0.498
F31					0.753				0.338
H35						0.721			0.391
H36						0.758			0.307
H37						0.412			0.415
G32							0.678		0.281
G33							0.687		0.301
A2								0.459	0.630
A3								0.491	0.530

Note. EA: Emotional Awareness; AR: Attention Regulation; ND: Non-Distracting; NW: Not-Worrying; SR: Self-Regulation; T: Trusting; BL: Body Listening; N: Noticing.

Table A.8: Factor Loadings for MSDS

	Factor	Uniqueness
Q1		0.974
Q2	0.381	0.855
Q3		0.943
Q4	0.355	0.874
Q5		0.958
Q6	0.542	0.706
Q7	0.374	0.860
Q8	0.618	0.618
Q9	0.490	0.760
Q10		0.944
Q11	0.603	0.636
Q12	0.458	0.790
Q13		0.967

Table A.9: Factor Loadings for NARS

	SocialInf	Emo	Interact	Uniqueness
A2	0.735			0.452
C9	0.481			0.469
A13	0.617			0.515
A11	0.915			0.391
C7		0.675		0.517
C8		0.652		0.688
C10		0.822		0.334
C12		0.552		0.365
C4		0.428		0.453
B5			0.864	0.321
B6			0.890	0.328
A1			-0.559	0.456
A14				0.845

Note. SocialInf: Negative attitude towards robots in terms of social influences; Emo: negative attitude towards robots in terms of emotions; Interact: interaction with robots.

Table A.10: Structural Matrix for PANAS

Emotions	*Mean (M)*	*Total r*
Distressed	58.68	0.500
Guilty	35.3	0.507
Nervous	41.54	0.482
Irritated	49.5	0.411
Frightened	35.08	0.467
Unhappy	51.48	0.586
Scared	33.78	0.550
Unfriendly	30.06	0.567
Ashamed	36.06	0.429
Annoyed	43.94	0.475
Interested	75.2	0.506
Excited	60.88	0.507
Strong	67.54	0.659
Enthusiastic	68.86	0.458
Awake	64.7	0.653
Careful	70.5	0.514
Proud	62.62	0.641
Inspired	59.9	0.598
Determined	67.86	0.552
Active	69.62	0.535

Note. First part is responded to negative emotions; second part is responded to positive emotions. M is proportion of feeling of that emotions; Total r is corresponded to Pearson's r for correlation with general feeling of that emotions.

Table A.11: Correction Table for RMET

Question No	*Total correct ratio %*
Q1	73.51
Q2	87.03
Q3	72.97
Q4	77.30
Q5	62.16
Q6	61.62
Q7	49.19
Q8	82.70
Q9	90.27
Q10	44.86
Q11	71.89
Q12	55.14
Q13	62.16
Q14	80.00
Q15	69.19
Q16	84.86
Q17	80.54
Q18	88.11
Q19	71.35
Q20	91.35
Q21	60.00
Q22	76.76
Q23	63.78
Q24	83.24
Q25	95.68
Q26	82.16
Q27	89.73
Q28	87.57
Q29	85.41
Q30	64.86
Q31	67.57
Q32	84.32

Table A.12: Factor Loadings for ULS-20

	Factor	Uniqueness
Q1	0.731	0.465
Q2	0.550	0.697
Q3	0.663	0.560
Q4	-0.363	0.868
Q5	0.662	0.562
Q6	0.559	0.688
Q7	0.695	0.517
Q8	0.532	0.717
Q9	0.454	0.794
Q10	0.743	0.447
Q11	0.618	0.618
Q12	0.519	0.731
Q13	0.615	0.622
Q14	0.655	0.571
Q15	0.386	0.851
Q16	0.780	0.391
Q17	0.555	0.692
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Q19	0.699	0.511
Q20	0.793	0.371

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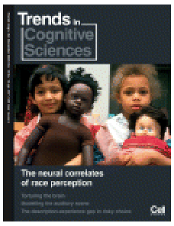

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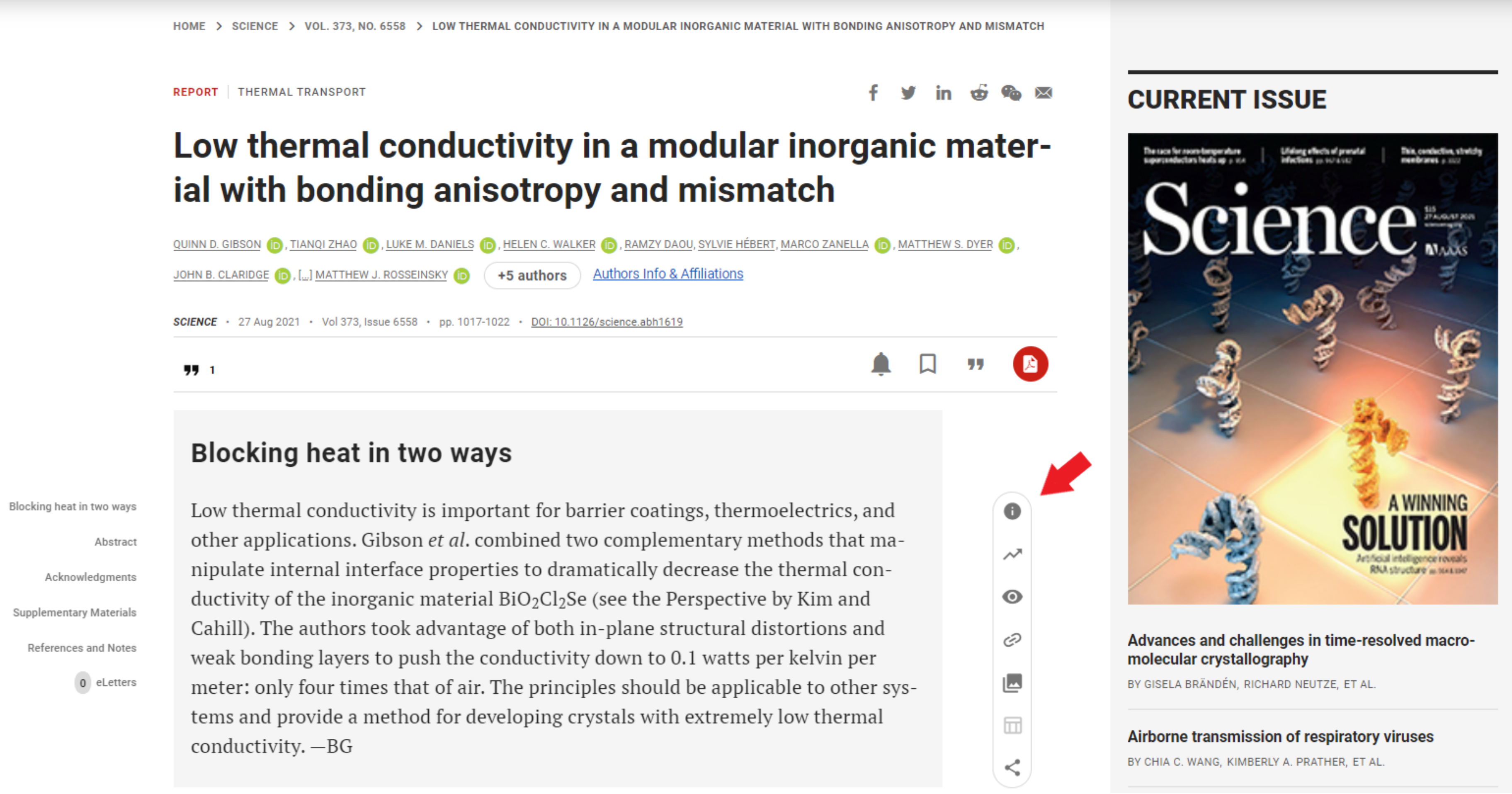

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