

The Relationship Between Metacognition and Mentalization: A Cross-Sectional Study

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Abstract

For decennia, humans have speculated about and have come up with theories explaining the concept of the self. Recent research has suggested that the self is composed out of multiple, di processes, including both metacognition and mentalization. Metacognition is a higher-order cognitive process that involves the monitoring and regulation of a person's own thoughts and behaviour. Mentalization is the ability to understand mental states in both oneself and others. These definitions are quite similar to each other, and both concepts have been proven to play an important role for processes like social cognition, emotional regulation and mental health. However, studies that compare the two concepts are extremely scarce. As both concepts have emerged from different fields, there may be the possibility that the two concepts are used to measure the same process. Therefore, this study investigated the relationship between metacognition, mentalization and two other related concepts – epistemic trust and interoceptive awareness – using an online questionnaire with a cross-sectional method.

The first hypothesis – proposing that there is a positive correlation between metacognition and mentalization – found support by a significant, yet weak correlation. The second hypothesis, which tested the predictive effects of metacognition and mentalization on epistemic trust and interoceptive awareness, yielded mixed results. While mentalization was not found to have any relation with epistemic trust and interoceptive awareness, metacognitive abilities did have a significant relationship with epistemic trust. However, no significant relationship was found between metacognition and interoceptive awareness. Limitations of the study included a low internal consistency on the metacognition questionnaire, potential sample biases due to recruitment methods, and the impact of the survey length on patient attentiveness.

The Relationship Between Metacognition and Mentalization: A Cross-Sectional Study

Humans have been interested in the concept of the self and self-awareness since decennia. The term of ‘the self’ was already introduced by the Ancient Greek, whose religions helped to develop and mature human consciousness, which increased people’s self-awareness and consciousness (Hong-Chen, 2010). Over time, the concept of the self has been refined by psychologists as James, Klein, and Freud (Mann, 1996). This interest is also visible in psychological research, where many different theories about the self and self-awareness have been proposed. Recently, a theory has been proposed which suggests that the self is composed of multiple processes. This theory also proposes that one of the most important elements in the relationship between the body and the self is metacognition (Lage, 2022).

Metacognition can be described as a series of processes that a person uses to monitor the cognitive activities that are existing in the person’s mind, which plays an important role in controlling that person’s behaviour (Rhodes, 2019). This “thinking about thinking” is assumed to be somewhat divided in two parts. The first is metacognitive knowledge, which includes the capacity to be aware of one’s own cognitive processes. Secondly, there is metacognitive control, which refers to the ability to regulate these processes (Fleur et al, 2021). Metacognition is of great importance, as it contributes to the effective management of a person’s own mind. This allows for a person to have full control over their own thoughts and beliefs (Kuhn et al., 2021).

Metacognition is one of the higher-order cognitive processes, as it enables a person to be aware of and to control their own cognitive functions (Drigas & Papas, 2017). It is thought that metacognition is one of the most important mechanisms for the processing of social and cognitive information and plays an important role in developing and maintaining interpersonal relationships (Battistelli & Franeti, 2015). Another mechanism that plays a role in these skills and is closely related to metacognition is Theory of mind, which involves the ability of an individual to attribute the mental states of both themselves and others, and recognizing the relationship that connects these mental states with behaviour (Misailidi, 2010). In summary, metacognition and theory of mind both play a role in the development of executive skills and social interaction abilities (Victoria & Athanasios, 2023).

Another division that can be made within the concept of metacognition is between metacognition at the local or global level. The local level of metacognition includes a person’s regulation of his or her ongoing mental processing when it is essential for the performance of

a discrete task (Hohendorf & Bauer, 2023). This includes for example a person's ability to notice changes in the moment-to-moment cognitive processes (Bhome et al., 2021). Conversely, the global division of metacognition includes a person's awareness and regulation of mental activity that can be seen as general properties of him or herself (Hohendorf & Bauer, 2023). Global metacognition pertains to for example a person's belief about his or her own abilities and skills (Seow et al., 2021). This separation is important for the clinical setting, as frameworks focusing on global metacognition may be more directly relevant to the patients than frameworks focusing on local metacognition. Additionally, the global level of metacognition is proven to play a very important role in treatment adherence in patients, as they may only be willing to participate when they have this insight in their symptoms (Seow et al., 2021).

It has been suggested by Efklides et al. (2006) that metacognitive activity plays a very important role in the learning process. This is because these experiences can cause both quick, unconsciously controlled decisions, or consciously and analytic controlled decisions, which affects a person's self-regulation and self-confidence. Next to that, research has also indicated metacognition to be associated to mental health. For instance, it has been found that individuals with psychosis-related mental disorder symptoms have a reduced metacognitive sensitivity (Hohendorf et al., 2023) as, the delusional thinking patterns in people with schizophrenia is hypothesized to be caused by metacognitive errors such as a lack of cognitive insight (Engh et al., 2009). Furthermore, negative metacognitive beliefs regarding worrying and uncontrollability have been found to play a role in anxiety and depression across various physical illnesses (Capobianco et al., 2020). Recently, a form of psychotherapy has been created that focuses on alterations of metacognitive skills. These therapies have demonstrated improvements in a series of psychopathological variables that are existent in personality disorders (Carcione et al., 2019), depression and anxiety (Rochat et al., 2018).

Metacognition is also thought to play a role in a process called interoceptive awareness. Interoception refers to the sensation of the internal body states, and the term interoceptive awareness – also known as interoceptive metacognition – is used as the collaboration between the objective accuracy of a person's interoceptive perception, and the subjective confidence about this accuracy (Garfinkel et al., 2015). When metacognition functioning and thus also this interoceptive awareness is diminished during for example a mental illness, a patient's symptom severity can increase (Arbel et al., 2013). Additionally, deficits in interoceptive awareness have also been found to play a role in the experience of dissociative symptoms of patients with first episode psychosis (Garfinkel et al., 2018).

To sum up, metacognition is a higher-order cognitive skill that is of profound importance for a person's daily functioning, playing a role in the development of social cognition and learning processes. Additionally, metacognition has been found to have an influence on mental health and psychological disorders.

Mentalization

Another term that is often used in psychological research, which seems similar to metacognition, is 'mentalization'. This is used to refer to a person's ability to be aware of the mental activity and behaviours of both the self, as well as other people, which includes that person's beliefs, desires, and intentions (Clutterbuck et al., 2021). The term was first introduced by Fonagy in 1989 in relation to an empirical study researching infant attachment (Fonagy & Allison, 2011). Back then, the term was used in a relatively broad way, and has over the years been developed in relation to mental health and psychological disorders (Bateman & Fonagy, 2010). Nowadays, mentalization can be developed as the "ability to understand actions by other people and oneself in terms of thoughts, feelings, wishes and desires" (Bateman & Fonagy, 2016, p. 3).

Research has suggested that mentalization comprises of four different dimensions. The firstly, and probably the most important dimension, is automatic versus controlled mentalization. Automatic mentalization is a quick, reflexive, and parallel, and requires less effort. (Luyten et al., 2020). This process is thought to be based mostly on information coming in directly from our senses, without using too much higher processing in the brain. However, therefore automatic mentalization is more sensitive for bias and distortions, especially during more complex interpersonal interactions (Luyten & Fonagy, 2015).

In contrast, controlled mentalization is thought to be a more conscious and reflective process, that is associated with both symbolic and linguistic processing. It has been suggested that the latter process is involved in the evolutionary progress in the capacity for cooperation and mutuality between humans (Luyten et al., 2020). Controlled mentalization enables persons to reflect on and make attributions about the thoughts, intentions, and emotions of both the self and others (Luytem & Fonagy, 2015).

Secondly, there is the dimension of mentalizing with regard to others, and mentalizing with regard to the self. Mentalizing to the self is concerned with the experience of the person

himself (Rothschild-Yakar et al., 2019), and is assumed to be involved in mindfulness exercises (Choi-Kain & Gunderson, 2008). Mentalizing with regard to others, on the other hand, is concerned with the experience of the other people (Rothschild-Yakar et al., 2019). This form of mentalization is generally thought to be involved in a person's ability to experience empathy and a person's theory of mind (Choi-Kain & Gunderson, 2008),

Thirdly, there is the dimension of mentalization built upon internal or external features of both the self and others. Here, the internal features refer to mentalization that focuses on either one's own or another person's mental interior, which comprises of a person's thoughts, feelings, or experiences. (Lieberman, 2006). This form of mentalizing is used to make attributions using a focus on the mental interior of the self and others (Luyten & Fonagy, 2015). The external features, on the other hand, refer to mentalization that focuses on one's own or another person's physical, visible features and actions (Lieberman, 2006). This form of mentalization thus uses features like a person's body posture and facial expressions (Luyten & Fonagy, 2015).

Lastly, another dimension comprises of cognitive versus affective mentalization. The cognitive mentalizing relies largely on controlled mentalizing and includes a person's capacity for perspective taking and the capacity for belief-desire reasoning, which involves a person's ability to understand and predict another person's behaviour based on his or her desires and beliefs (Luyten et al., 2020). On the contrary, affective mentalizing is considered to be a largely automatic process. Here, a person uses social signals like facial expressions to make inferences about the affective states of other people (Takahashi et al., 2015).

It has been suggested that an imbalance in these four dimensions of mentalization is implicated in multiple psychological disorders, such as Anorexia Nervosa (Skarderud, 2007) and major depressive disorder (Fischer-Kern & Tmej, 2019). Furthermore, mentalization-based treatment (MBT) has been found to be an effective treatment method for individuals with borderline personality disorder because it improves the person's emotion regulation and impulsivity during interpersonal interactions (Bateman, 2010). Additionally, the use of mentalizing skills by a psychotherapist have been proven to be important for the effectiveness of psychotherapeutic interventions because it helps the therapist to recognize the client's mental state and serves as an aid to help them understand their own behaviour (Fonagy & Allison, 2014).

Similarities and Discrepancies between Metacognition and Mentalization

When looking at the definitions of metacognition and mentalization, the two concepts appear to be very similar. It seems that when the cognitive monitoring is directed at the self it would be classified as metacognition, but when the monitoring is directed at other people, it would be classified as mentalization (Ridenour et al., 2018). Despite this, metacognition and mentalization have developed independently from each other, emerging from different research paradigms. (Lysaker 2014).

Empirically speaking, metacognition and mentalization are both important processes that can influence our social and cognitive performance and our mental health. They are both involved with meta-level representations of mental states (Jiang et al., 2022). Additionally, metacognition and mentalization share similar neural circuits, which helps suggest that those regions play a role in second-order representations that are used to think about both thoughts of the self, as well as of others (Vaccaro et al., 2018). Additionally, impairments in both mentalization skills and metacognition have been suggested to play a role in the experience of psychosis (Lysaker et al., 2021). Both psychotherapies based on metacognition and mentalization appear to be effective for patients experiencing psychosis, as targeting both metacognitive and mentalizing skills in these patients have improved the patient's social experiences (Ridenour et al., 2018).

The link between metacognition and mentalization can also be found in the relation to the concept of epistemic trust. Where Greely (2021) categorized epistemic feelings – which play a role in the development of epistemic trust – as a form of metacognition, Bateman & Fonagy (2019) have found a significant role for epistemic trust in the development of mentalizing skills. These skills already develop in infancy through an infant's caregivers. When these mirror and validate the emotional experiences of the child, it encourages the ability for the child to understand both their own and other people's mental states (Bateman & Fonagy, 2019). However, this development can be hindered by an imbalance of epistemic trust in the person. This epistemic trust is a person's ability to judge the trustworthiness and applicability of information they receive from an external source. When a child is raised in an environment with insecure attachment, this can hinder social learning and can make the child suspicious of incoming information, leading to low epistemic trust and lower mentalization (Parolin et al., 2023). Thus, it can be argued that epistemic trust could serve as an overlap between metacognition and mentalization.

To conclude, there are a few indications based on prior studies that metacognition and mentalization could possibly be related, as they share similar neural circuits, and they are both

important for a person's well-being. As there is a lack of studies comparing metacognition and mentalization on both a theoretical, as well as on an empirical level, there might be a possibility that metacognition and mentalization actually measure the same thing, but the concepts have just emerged from different fields of study.

To investigate whether there is an actual difference between metacognition and mentalization, the first hypothesis that this study aims to answer is whether there is a positive correlation between metacognition and mentalization. Considering the aforementioned links between metacognition and interoceptive awareness, as well as the link between metacognition, mentalization and epistemic trust, the second hypothesis that this study aims to answer is whether metacognitive abilities and mentalization skills have a positive influence on a person's epistemic trust and interoceptive awareness.

Methods

The study was conducted using an online survey through Qualtrics. Here, the participants filled in four questionnaires, one for each construct: metacognition, mentalization, epistemic trust and interoceptive awareness. The study was conducted using a cross-sectional method. This research was approved by the BMS ethics committee at 20-09-2024. The data collection period lasted from 05-10-2024 until 24-11-2024.

Sampling method

The sample was recruited by both using an online flyer that was distributed using social media, as well as using the Utwente SONA Systems application. This platform is used by the faculty of Behavioural, Management and Social Sciences of the University of Twente. Students can sign up for studies performed by other students of the faculty and get credits for participating. Each student needs to reach a certain number of credits in order to graduate. For this questionnaire, students received 0.25 credits after they completed the survey. Participants were excluded if they were falling outside the age range of 18-30. Additionally, data that was incomplete was also removed from the dataset.

Procedure

The data was collected using Qualtrics. Each participant could follow a link to the survey, either via social media or via the Utwente SONA Systems program. The survey took approximately 20 minutes to complete. Before starting the survey, the participants first received an online informed consent form. Here, the purpose of the study, as well as the procedure, information about confidentiality and the way the data was handled, as well as the voluntary nature of the participation was addressed. If the participant did not give consent, he or she could not fill in the rest of the survey. Participants couldn't skip any questions to prevent missing data, but they did have the option to go back to a previously answered question. After giving consent, the questionnaire started with a few demographic questions used to get an overview of the sample. When the demographic questions were filled in, the four questionnaires measuring metacognition, mentalization, epistemic trust and interoceptive awareness followed. After all questions were filled in, the participants received a short debrief with the contact information of the researchers in case they had any questions about participation or about the research itself.

Materials.

The first test used in the questionnaire is the Metacognition Questionnaire (MCQ-30) test. This test measures a person's metacognitive performance using 30 items, divided over 5 subscales; cognitive confidence, positive beliefs, cognitive self-consciousness, uncontrollability, and danger and need to control thoughts. The test uses a Likert scale with four response options: do not agree, slightly agree, agree moderately, and agree very much (Wells & Cartwright-Hatton, 2004). For this questionnaire, the MCQ-30 scored an unacceptable Cronbach's alpha of $\alpha = .25$.

Following the MCQ-30, the second test used in the questionnaire is the Certainty about Mental States Questionnaire (CAMSQ). This test measures a person's perceived capability to understand the mental states of him- or herself and other people. The test uses 20 items divided over 2 subscales: Other-certainty and Self-certainty, reflecting the previously named reflection of mentalizing with regard to the self versus mentalizing with regard to others. This test uses a 5-point Likert scale with response options for strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree and strongly agree (Muller et al., 2021). The CAMSQ scored an acceptable Cronbach's alpha of $\alpha = .74$.

The Epistemic Trust, Mistrust and Credulity Questionnaire (ETMCQ) was used to measure the respondent's level of trust in communicated knowledge. The test consists of 15 items divided over three subscales: trust, mistrust and credulity. The ETMCQ also uses a 5-point likert scale with the response options being strongly disagree, disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree and strongly agree (Campbell et al., 2021). The ETMCQ scored a questionable Cronbach's alpha of $\alpha = .65$.

Lastly, the Multidimensional Assessment of Interoceptive Awareness test (MAIA-2) was used to investigate the respondent's level of conscious interpretation and integration of different signals that originate from within the body. This questionnaire consists of 37 items scored on a 5-point Likert scale, ranging from never till always. The questionnaire contains 8 subscales: noticing, not-distracting, not-worrying, attention regulation, emotional awareness, self-regulation, body listening and trusting (Mehling et al., 2018). The MAIA-2 scored an acceptable Cronbach's Alpha of $\alpha = .74$.

Data Analysis

The data analysis was done using Rstudio version 2024.04.0735. The libraries tidyverse and dplyr, lme4, ggcorrplot and ggplot2, were used for the analysis. First, the items

of the MSQ-30 test and items 4 till 9, 11, 12, and 15 of the MAIA-2 questionnaires were reverse-coded. This was done because a high score on the MSQ-30 and the previous named items of the MAIA-2 questionnaire indicated poor functioning, whereas a high score on the other items of the questionnaires indicated good functioning. Furthermore, the descriptive statistics of the variables gender, age, and nationality were computed to get an overview of the demographic characteristics of the sample size. Additionally, the Pearson's correlation coefficient was used to investigate the relationship between metacognition, mentalization, epistemic trust and interoceptive awareness.

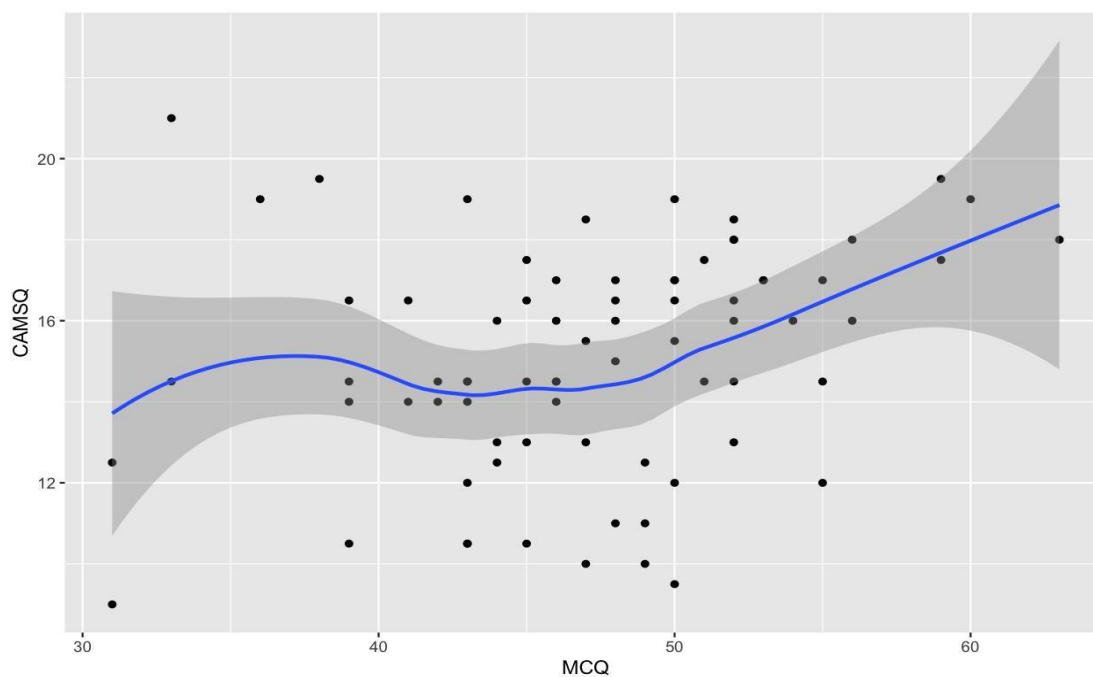
Results

After removing four participants with missing data, the sample size consisted of 74 participants, of which 23 identified as male, 53 as female, and 2 as being a third gender. All the participants fell in the age group of 18 to 30 years old, with a mean age of $M = 20.96$ years ($SD = 2.17$). The participants were of 12 different nationalities, with the biggest proportion of 39 respondents being from the Netherlands and 23 from Germany.

To test the first hypothesis – that there is a positive correlation between metacognition and mentalization – a Pearson’s correlation was calculated, which suggests a significant but weak positive correlation ($r = .26, p = .03$). The relationship was then visualized using a scatterplot displaying the result of each respondent on both the MCQ-30 and the CAMSQ tests, the results of which can be seen in Figure 1.

Figure 1

Scatterplot displaying the results of individual respondents on the MSQ-30 and CAMSQ test



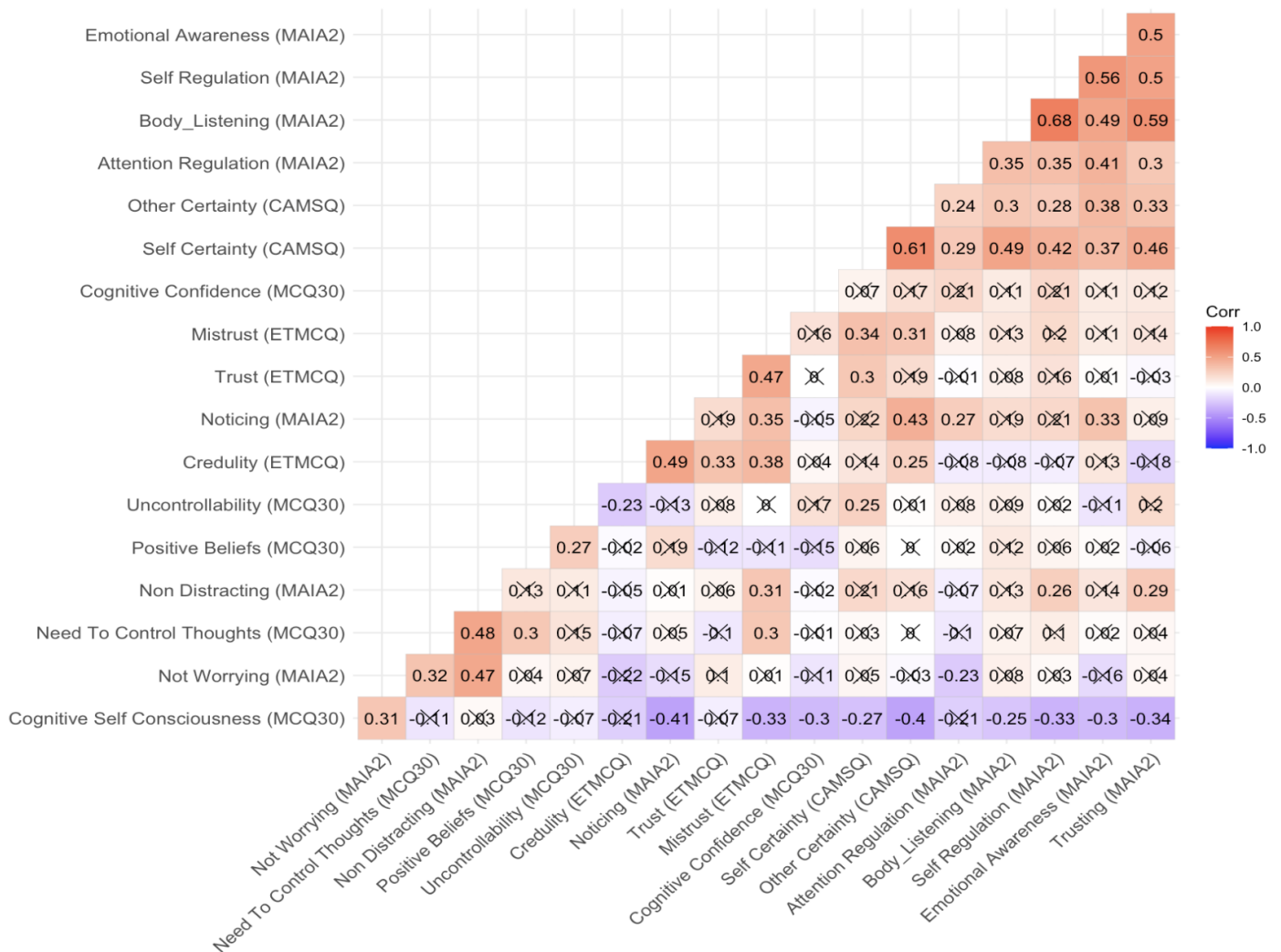
Note: Calculations are based on a sample of $N = 74$. CAMSQ = Certainty about Mental States Questionnaire, MSQ = Metacognition Questionnaire

To test the second hypothesis – that metacognition abilities and mentalization skills have a positive influence on epistemic trust and interoceptive awareness– a correlational matrix was made using the `ggcorrplot()` function to investigate the correlations between all the

subscales of the four different questionnaires, the result of which can be found in Figure 2. 55 out of the total 153 correlations were significant, with the strongest relationships after the control for multiple testing being the correlations between Body listening of the MAIA-2 and Self-Regulation of the MAIA 2 ($r = .68, p = .49$), Self-Certainty of the CAMSQ and Other Certainty of the CAMSQ ($r = .61, p = 1.00$), Body Listening of the MAIA-2 and Trusting of the MAIA-2 ($r = .59, p = 1.00$) Self-Regulation of the MAIA-2 and Emotional awareness of the MAIA-2 ($r = .56, p = 1.00$, and lastly Emotional awareness of the MAIA-2 and Trusting of the MAIA-2 ($r = .50, p = .>01$, as well as Self-Regulation of the MAIA-2 and Trusting of the MAIA-2 ($r = .50, p = .15$).

Figure 2

Correlational Matrix of the Subscales



Note: Calculations are based on a sample size of $N = 74$ and a P-value of $p = .05$. The darker the shade of colour, the stronger the correlation between two variables.

Additionally, a regression model with predictor variables metacognition (MSQ) and mentalization (CAMSQ) and outcome variables interoceptive awareness (MAIA2) and epistemic trust (ETMCQ) was performed that was used to test for hypothesis number 2, the results of this analysis can be found in Table 1 and 2. As shown in Table 1, the MSQ shows a significant result for the relationship between metacognition (MSQ) and epistemic trust (ETMCQ). The amount of variance explained by metacognition, however, remains low with an R^2 of .097. There was no significant result found between the relationship between the relationship with metacognition (MSQ) and interoceptive awareness (MAIA 2). Table 2 shows that for mentalization (CAMSQ), there were no significant relationships with both epistemic trust (ETMCQ) and interoceptive awareness (MAIA 2).

Table 1*HTML Table with Output Regression Model MSQ*

<i>Predictors</i>	<i>Estimates</i>	MAIA 2		<i>P</i>	ETMCQ	
		<i>CI</i>	<i>P</i>		<i>Estimates</i>	<i>CI</i>
(Intercept)	2.85	2.14 – 3.57	< 0.001	3.94	3.41 – 4.48	< 0.001
MSQ	0.01	-0.00 – 0.03	0.107	0.06	0.02 – 0.11	0.007
Observations	74			74		
R^2 /Adjusted R^2	0.036/0.022			0.097/0.084		

Note: Calculations are based on a sample size of $N = 74$ and a P-value of $p = .05$.

Table 2*HTML Table with Output Regression Model CAMSQ*

<i>Predictors</i>	<i>Estimates</i>	MAIA 2		<i>P</i>	ETMCQ	
		<i>CI</i>	<i>P</i>		<i>Estimates</i>	<i>CI</i>
(Intercept)	3.94	-3.53 – 7.73	<0.001	8.00	6.33 – 9.667	< 0.001
CAMSQ	-0.03	-0.07 – 0.00	0.056	0.04	-0.07 – 0.14	0.522
Observations	74			74		
R^2 /Adjusted R^2	0.050/0.036			0.006/-0.008		

Note: Calculations are based on a sample size of $N = 74$ and a P-value of $p = .05$.

Discussion

The aim of this research was to investigate whether metacognition and mentalization are indeed two distinct processes, and do not measure the same concept. This was done using two hypotheses. The first, and main hypotheses, was that metacognition and mentalization were positively correlated. Additionally, to explore the relationship between metacognition and mentalization further, the influence of metacognition and mentalization was tested in relation to two other, related constructs. Therefore, hypothesis number 2 was that metacognitive abilities and mentalization skills have a positive influence on a person's epistemic trust and interoceptive awareness.

The first hypothesis was tested using a person's correlation and a correlational matrix. The Pearson's correlation showed a weak, but significant correlation, which means that the hypothesis can be accepted. The significant P-value indicates that the two concepts are indeed related to each other, but the weak correlation also indicates that metacognition and mentalization are indeed two separate constructs, and the two questionnaires do not measure the same thing. This finding of a positive correlation can help explain the involvement of both mentalization and metacognition in the experience of psychosis, found by Lysaker et al., (2021).

The second hypothesis was tested using a regression model. No significant relationships were found for the influence of mentalization skills on interoceptive awareness and epistemic trust, contrary to the suggested link by Bateman & Fonagy (2019) and Parolin et al., (2023). Additionally, there also was no significant relationship between mentalizing skills and interoceptive awareness, which is contradictory to the notion of mentalizing interoception used by Dugette & Ainly (2019)

For metacognition, the suggested link with interoceptive awareness found by Garfinkel & Critchley (2013) could not be replicated, as there were no significant findings. There was, however, a significant relationship between metacognition and epistemic trust. This means that a person's metacognitive abilities can have an influence on a person's level of epistemic trust. This significant finding can be explained by the research of Greely et al. (2021), who found an important role for the metacognitive 'feelings of knowing' in the development of epistemic trust.

Limitations

There are a few limitations to the current study. The Cronbach's alpha of the MCQ-30 questionnaire was very low for this sample ($\alpha = .25$). Therefore, the claims of significant findings in both hypotheses should be taken with caution, as it may decrease the reliability of the results on this test for this sample. This might also be a reason why the findings of Garfinkel & Critchley (2013) suggesting a link between metacognition and interoceptive awareness could not be replicated.

When looking at the sample, there might be bias considering the fact that there were only two methods of recruitment (SONA System from the UTwente BMS faculty and social media) which can lead to a lower generalization. This can be seen in for example the nationality of the participants being largely German or Dutch. Additionally, since the participation was voluntary and was done using self-sign-up, this may reflect characteristics that are not completely generalizable to the bigger population.

One other limitation was the survey length. Since the survey was 20 minutes long, this might have led to participants getting tired, losing their attention, thinking less well about their answer, and maybe clicking the wrong answer because of sloppiness as the survey progressed. This could affect scores on later questionnaires such as the MAIA-2, which may play a role in the absence of significance in the results of this questionnaire. It might have happened that people thought less well about their answers due to having lost their attention, and they thus picked a different answer than they would have done if they took the time to think the questions through a bit more.

Recommendations

Based on these findings and limitations, there are a few recommendations for further research. First, it might be successful to use other methods of recruitment, in order to ensure for more variety in the sample. This might also have a positive effect for the Cronbach's Alpha of the MCQ-30, which makes the claims the study can make more reliable.

Additionally, it would be interesting to further investigate the effect of the two different subscales of the CAMSQ questionnaire measuring mentalization. The creators of the questionnaire chose to create two subscales: self-certainty and other-certainty, which appears to reflect the discrepancy of mentalizing with regard to the self and mentalizing with regard to others (Rothschild-Yakar et al., 2019). The results show that the self-certainty subscale overall has higher correlations with the other subscales than the other-certainty. It would therefore be interesting to investigate why this one subscale reaches higher correlations and

look whether this would have an influence on therapies focusing on enhancing mentalization skills, as it can further specify mentalizing training on the aspect of mentalizing that is performing the worst instead of just mentalizing as a whole.

To conclude, this study aimed to investigate the relationship between metacognition and mentalization, and their effect on epistemic trust and interoceptive awareness. The findings of this study help with further specialization of other research, as it shows that metacognition and mentalization are two distinct but related processes. This helps gain further insight in our social cognition, and its relationship with the functioning of a person's mental health.

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Appendix I

```
---  
title: "Metacognition and Mentalization"  
output: html_document  
date: "2024-10-14"  
---
```

#1. Installing libraries

```
```{r libraries}  
install.packages("tidyverse")
install.packages("foreign")
install.packages("dplyr")
install.packages("ggplot2")
install.packages("lme4")
install.packages("ltm")
install.packages("psych")
install.packages("ggcorrplot")
install.packages("readxl")
install.packages("sjmisc")
install.packages("sjPlot")
install.packages("sjlabelled")
```
```

#2 loading libraries

```
```{R Library}  
library(tidyverse)
library(dplyr)
library(tidyverse)
library(ggplot2)
library(lme4)
library(ltm)
library(ggcorrplot)
```

```
library(readxl)
library(sjPlot)
library(sjmisc)
library(sjlabelled)
```
```

#3. Load dataset

```
```{r load dataset}
mcmt <-read_xlsx("metacognition and mentalization.xlsx")
view(mcmt)
```
```

#4. Remove columns unnecessary for data analysis

```
```{r clean dataset}
df = mcmt[,!(names(mcmt) %in% c("StartDate", "EndDate", "Status", "Progress", "Duration (in
seconds)", "Finished", "RecordedDate", "ResponseId", "UserLanguage", "Q_RecaptchaScore", "
DistributionChannel"))]

```
```

#5. Remove rows unnecessary for data analysis

```
```{r clean dataset}
df <- df [-c(1),]
```
```

#6 Remove rows with missing data

```
```{R missing data}
df<-df[-c(17,33,36,23),]
```
```


#7 Make the dataset numeric

```
```{r numeric}  
df[, c(3,6:108)] <- lapply(df[, c(3,6:108)], as.numeric)
```

```
```
```

#8 reverse code necessary items

```
```{r reverse code}
```

```
df <- df %>%
 mutate(...17 = 5 - ...17,
 ...18 = 5 - ...18,
 ...19 = 5 - ...19,
 ...20 = 5 - ...20,
 ...21 = 5 - ...21,
 ...22 = 5 - ...22,
 ...23 = 5 - ...23,
 ...24 = 5 - ...24,
 ...25 = 5 - ...25,
 ...26 = 5 - ...26,
 ...27 = 5 - ...27,
 ...28 = 5 - ...28,
 ...29 = 5 - ...29,
 ...30 = 5 - ...30,
 ...31 = 5 - ...31,
 ...33 = 5 - ...32,
 ...33 = 5 - ...33,
 ...34 = 5 - ...34,
 ...35 = 5 - ...35,
 ...36 = 5 - ...36,
 ...37 = 5 - ...37,
 ...38 = 5 - ...38,
```

```

...39 = 5 - ...39,
...40 = 5 - ...40,
...41 = 5 - ...41,
...42 = 5 - ...42,
...43 = 5 - ...43,
...44 = 5 - ...44,
...45 = 5 - ...45,
...46 = 5 - ...46,
...87 = 5 - ...87,
...88 = 6 - ...88,
...89 = 6 - ...89,
...90 = 6 - ...90,
...91 = 6 - ...91,
...92 = 6 - ...92,
...94 = 6 - ...94,
...95 = 6 - ...95,
...98 = 6 - ...98)

```

```

...

```

```

#9 Calculate the subscores for the MCQ-30

```

```

```{r subscore}

```

```

#Cognitive Confidence

```

```

df$'Cognitive Confidence (MCQ30)' <- rowSums(df[, c(6:11)], na.rm = TRUE)

```

```

#Positive Beliefs

```

```

df$'Positive Beliefs (MCQ30)' <- rowSums(df[, c(12:17)], na.rm = TRUE)

```

```

#Cognitive Self-Consciousness

```

```

df$'Cognitive Self Consciousness (MCQ30)' <- rowSums(df[, c(18:23)], na.rm = TRUE)

```

```

#Uncontrollability

```

```

df$'Uncontrollability (MCQ30)' <- rowSums(df[, c(24:29)], na.rm = TRUE)

```

```

#Need to control thoughts
df$'Need To Control Thoughts (MCQ30)' <- rowSums (df[, c(30:35)], na.rm = TRUE)
#
...

#10 Calculate the subscores for the CAMSQ

```{r subscore}
#Self-Certainty
df$'Self Certainty (CAMSQ)' <- rowMeans(df[,c(36,39,40,42,44,46,48,49,51,55)], na.rm =
TRUE)

#Other-Certainty
df$'Other Certainty (CAMSQ)' <- rowMeans(df[,c(37,38,41),43,45,47,50,52,53,54], na.rm =
TRUE)

...

#11 Calculate the subscores for the ETMCQ

```{r subscore}
df$'Trust (ETMCQ)' <- rowMeans(df[,c(56,57,62,63,68)], na.rm = TRUE)
df$'Mistrust (ETMCQ)' <- rowMeans(df[,c(58,59,64,65,69)], na.rm = TRUE)
df$'Credulity (ETMCQ)' <- rowMeans(df[,c(60,61,66,67,70)], na.rm = TRUE)

...

#12 Calculate the subscores for the MAIA-2

```{r subscore}
df$'Noticing (MAIA2)' <- rowMeans(df[,c(71,72,73,74)], na.rm = TRUE)
df$'Non Distracting (MAIA2)' <- rowMeans(df[,c(75, 76, 77, 78, 79)], na.rm = TRUE)

```

```
df$'Attention Regulation (MAIA2)' <- rowMeans(df[,c(85,86,87,88,89,90,91)], na.rm =
TRUE)
df$'Emotional Awareness (MAIA2)' <- rowMeans(df[,c(92,93,94,95,96)], na.rm = TRUE)
df$'Body_Listening (MAIA2)' <- rowMeans(df[,c(101,102,103)], na.rm = TRUE)
df$'Trusting (MAIA2)' <- rowMeans(df[,c(104,105,106)], na.rm = TRUE)
df$'Not Worrying (MAIA2)' <- rowMeans(df[,c(80,81,82,83,84), na.rm = TRUE])
df$'Self Regulation (MAIA2)' <- rowMeans(df[,c(97,98,99,100)], na.rm=TRUE)
...

```

#13 Calculate the score for the MSQ

```
```{r subscore}
df$MCQ <- rowSums(df[,c(110, 109, 108, 107, 106)])
df$CAMSQ <- rowMeans (df[,c (112, 111)], na.rm = TRUE)
df$ETMCQ <- rowMeans (df[,c(115, 114, 113)], na.rm = TRUE)
df$MAIA2 <- rowMeans(df[,c(123, 122, 121, 120, 119, 118, 117, 116)], na.rm = TRUE)
...

```

#14 Calculate Chronbach's Alpha

```
```{r alpha}
Load necessary library
library(psych)

#Calculate alpha MSQ
cronbach_alpha_MCQ <- alpha(df[,c(109:113)])
cronbach_alpha_MCQ$total$raw_alpha

#Calculate alpha CAMSQ
cronbach_alpha_CAMSQ <- alpha(df[,c(114,115)])
cronbach_alpha_CAMSQ$total$raw_alpha

```

```

#Calculate alpha ETMCQ
cronbach_alpha_ETMCQ <- alpha(df[,c(116:118)])
cronbach_alpha_ETMCQ$total$raw_alpha

#Calculate alpha MAIA 2
cronbach_alpha_MAIA2 <- alpha(df[,c(119:126)])
cronbach_alpha_MAIA2$total$raw_alpha

...

#15 Calculate correlation matrix for all the subscales

```{r correlation}
# Calculate the correlation matrix for the specified columns
correlation_matrix <- cor(df[, 109:126], method = "pearson", use = "complete.obs")

# Display the correlation matrix
correlation_matrix

#check individual correlation
cor.test(df$MCQ, df$CAMSQ, method = "pearson")
cor.test(df$MCQ, df$ETMCQ, method = "pearson")
cor.test(df$MCQ, df$MAIA2, method = "pearson")

library(Hmisc)
rcorr_matrix <- rcorr(as.matrix(df[,127:130]), type = "pearson")
print(rcorr_matrix)

...

```

```

```{r correlation matrix}
corr <- round(cor(df[, 109:126]), 1)
head(corr)

p.mat <- cor_pmat(df[,109: 126])
head(p.mat)

ggcorrplot(correlation_matrix,
 method = "square",
 hc.order = TRUE,
 type = "lower",
 lab = TRUE,
 p.mat = p.mat)

```

```{r p-values }
#perform t-tests
t_test1 <- t.test(df$`Body_Listening (MAIA2)`, df$`Self Regulation (MAIA2)`)
t_test2 <- t.test(df$`Self Certainty (CAMSQ)`, df$`Other Certainty (CAMSQ)`)
t_test3 <- t.test(df$`Body_Listening (MAIA2)`, df$`Trusting (MAIA2)`)
t_test4 <- t.test(df$`Self Regulation (MAIA2)`, df$`Emotional Awareness (MAIA2)`)
t_test5 <- t.test(df$`Emotional Awareness (MAIA2)`, df$`Trusting (MAIA2)`)
t_test6 <- t.test(df$`Self Regulation (MAIA2)`, df$`Trusting (MAIA2)`)

#extract p values
p_values <- c(t_test1$p.value, t_test2$p.value, t_test3$p.value, t_test4$p.value,
t_test5$p.value, t_test6$p.value)

#Perform Bonferroni correction
p_adjusted <- p.adjust(p_values, method = "bonferroni")

view(p_adjusted)

```

```

```

#16 Create scatterplot displaying scores at MSQ and CAMSQ

```
```{r }
ggplot(df, aes(x = MSQ, y=CAMSQ))+
  geom_point()+
  geom_smooth()
  labs(x = "MSQ Score", y = "CAMSQ Score", title = "Scatterplot of MSQ vs CAMSQ
Scores")+
  theme_bw()

```

```
---
```

#17 Create a linear model to test for signifiante

```
``` {r significance}

m1 <- lm (MAIA2 ~ MSQ, data = df)
m2 <- lm (MAIA2 ~ CAMSQ, data = df)
m3 <- lm (ETMCQ ~ MSQ, data=df)
m4 <- lm (ETMCQ ~ CAMSQ, data = df)

tab_model(m1, m2, m3, m4)

```

```

```

#18 Calculate demographics

```
```{r demographics}
mean_age <- mean(df$...14, na.rm = TRUE)
sd_age <- sd(df$...14, na.rm = TRUE)

```

```
list(mean_age = mean_age, sd_age = sd_age)
```

```
...
```