



PhD Fund
 Application form

BASIC DATA

1 Details of the applicant(s) and candidate

1a Main applicant

Name, first name, title(s)	Christodoulou Aikaterini, MSc		
End contract			
Affiliation	University of Groningen		
Department	Science & Engineering	Section	
Tel	+306989887518	E-mail	a.christodoulou.3@student.rug.nl
Do you hold the ius promovendi? ¹	NO		

1b Co-applicant

Name, first name, title(s)	van Vugt Marieke, PhD		
End contract			
Affiliation	University of Groningen		
Department	Bernoulli Institute	Section	Cognitive Modelling
E-mail	m.k.van.vugt@rug.nl		
Do you hold the ius promovendi? ¹	NO		

1c Proposed PhD candidate

Name, first name, title(s)	Christodoulou Aikaterini, MSc
E-mail	a.christodoulou.3@student.rug.nl , katechristodoulou21@gmail.com
Date of birth	29/11/1995

¹ At least one of the (co-)applicants should have the ius promovendi.

2. Title of the proposal

The anxiety paradox: examining the role of rumination and worry in social interactions

3. Summary of the proposed research

Although people suffering from anxiety experience considerable difficulties in social functioning, not many studies have investigated the underlying cognitive and neural mechanisms mediating these effects. An important factor underlying such difficulties are rumination and worry, which distract people from engaging in productive social interactions. We seek to investigate how worry and rumination impact social interaction in the context of a tacit coordination (TC) task, while we record the associated neural mechanisms using hyperscanning methods. An important mechanism driving rumination and worry is self-referential thinking. For this reason, we intend to test the effects of self-dissolution practices such as meditation on rumination and worry, and following that, TC. The present project thus aims explore the unique contribution of those two stress-related components in social interactions and provide useful information about understanding the multifaced and complex nature of anxiety. Ultimately, we hope to be able to suggest more effective and targeted therapies to address these phenomena in treatment.

DESCRIPTION OF THE PROPOSED RESEARCH



PhD Fund Application form

4. Research proposal

Approximately one in three people will exhibit some form of anxiety disorder during their lifetime (Bandelow & Michaelis, 2015; National Institute of Mental Health, 2020). Especially, after the outbreak of the Covid-19 pandemic with associated restrictions on social life, people's mental health was severely impacted and anxiety symptomatology was greatly increased (Chaturvedi et al., 2021; Mohammadi et al., 2020). These Covid-19 related consequences highlight two major points. Firstly, humans are an inherently social species that crave social interactions. Secondly, social life is an integral part of well-being that can be significantly influenced by anxiety. These realizations pose an important question regarding the actual impact of anxiety in social life. With this proposal, our main aim is to investigate the role of anxiety in social interactions, the underlying cognitive and neural mechanisms, and propose more targeted treatments.

4a. Research topic

Humans exhibit a prodigious ability to successfully cooperate even when overt exchange of information is not possible. For cooperation to happen under such circumstances, it is necessary people to coordinate their decisions and perform joint actions (Kwaadsteniet & Dijk, 2012). Tacitly coordinating (Schelling, 1960) demands the collaborating individuals to dynamically adjust their strategies according to other people intentions and actions. To do this, individuals are assumed to create certain mental models about others' beliefs, emotional states and intentions. By relying on these presuppositions, people are then able to predict others' behavior and adapt their own to match their partners communicative system (Resches & Pérez Pereira, 2007).

The cognitive capacity to infer others' mental state is often referred to as mentalising or Theory of Mind (TOM; Baron-Cohen et al., 1985; Frith, 2012; Wimmer & Perner, 1983). TOM is said to deploy several subcomponents of Executive Functioning (EF; Leslie et al., 2004; Perner & Lang, 1999) such as inhibition, attentional shifting and working memory monitoring and updating (Miyake et al., 2000). In a previous study, we used EEG hyperscanning to examine the role of working memory (WM) on a TC task. Hyperscanning is a promising new approach that attempts to reveal the neural dynamics involved in multiparticipant settings by the synchronous measurement of interacting individuals' brains. Notably, we found decreased brain-to-brain coupling in brain regions related to social processing and cognitive control under high cognitive load as compared to low load. Accordingly, people are under high cognitive load less efficiently coordinated as opposed to when they were under low load.

To our knowledge, even though anxiety has strong effects on social behavior (Wu et al., 2013), there is not much work attempting to identify the underlying cognitive and neural mechanisms that impact social interactions. With this research proposal we wish to extend previous results and examine whether and how anxiety-related cognitive impairments influence TC in real-time multiparticipant settings using EEG hyperscanning. Specifically, anxiety consists of an interesting phenomenon to investigate as on the one hand it seems to improve the accuracy in perspective-taking mentalization (Knight et al., 2019; Zainal & Newman, 2018), while on the other hand, it impedes WM performance (Darke, 1988; Moran, 2016; Oei et al., 2006; but also see Lukasik et al., 2019). This would in turn hinder social coordination since as we have just established requires WM resources.



PhD Fund Application form

4b. Approach

In this project, we will investigate the possible impact of anxiety on TC, the underlying cognitive processes and neural mechanisms, and based on our findings explore different therapeutic interventions.

1st Study

To gain a better experimental insight into how anxiety symptomatology influences social coordination, we will perform a behavioral study using the basic paradigm of TC validated in our previous study. In addition to this, we will induce anxiety in healthy individuals by means a threat of shock. Our choice of healthy participants is based on the reason that clinically identified anxiety is often comorbid with other mental and psychiatric disorders and thus hard to determine which cognitive impairments can be attributed to anxiety (Bolton & Robinson, 2017).

Methods

- *Social coordination*: Pairs of participants will have to perform on TC task in which they will need to coordinate their actions over time and select the same image over a set of four abstract images.
- *Anxiety induction*:
 - **Plan A**: The pairs will perform the coordination task in two conditions: under threat of shock, i.e., administering non-painful electric shocks to participant's wrists at a pseudorandom time point, and neutral or safe condition that will be used as control. The threat of shock manipulation has been used in multiple studies showing that induced anxiety impairs -mainly- the encoding of new information and therefore WM performance (Bolton & Robinson, 2017; Robinson et al., 2013; Weymar et al., 2013).
 - **Plan B**: An alternative approach in case no significant outcomes emerge from the threat manipulation would be to more specifically target the social aspects of anxiety. An interesting approach would be participants to perform on the TC task while being submitted to a cold pressor test (CPT). This test is often used for anxiety induction as it activates the sympathetic nervous system (Lamotte et al., 2021) and is positively correlated with anxiety sensitivity (AS; Dodo & Hashimoto, 2017). Apart from inducing stress though, this manipulation incorporates physical coldness that is associated with social coldness (Bargh & Shalev, 2012; Zhong & Leonardelli, 2008). Following the reasoning of embodied cognition, we would thus expect the CPT to simultaneously evoke physical stress and psychological distress related to social interactions.
- *Self-report measures*:
 - Prior to experiment participants will answer the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1970) to control for trait anxiety.
 - As a manipulation check, participants will retrospectively report how anxious they felt (from 1 "not at all anxious," to 5 "extremely anxious") during the threat and



PhD Fund Application form

safe conditions.

- We will also administrate the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990) to examine the possible association between worrisome thinking and TC, and the Ruminative Responses Scale (RRS; Treynor, 2003) for checking ruminative thinking and TC.

Hypothesis

- › We predict that individuals under the threat of shock condition (or CPT) will less effectively manage to tacitly coordinate (lower accuracy) and will take more time to reach a decision (slower reaction times).
- › Moreover, we expect the PSWQ to either correlate positively or to be uncorrelated with TC, whereas the RRS to negatively correlate with TC.

2nd Study

To explore the possible underlying cognitive processes and neural mechanisms, after establishing that indeed anxiety has a significant impact on TC, we will expand on our hypothesis of the differential effects between *worry* and *ruminaton* on TC. Particularly, rumination refers to the abstract and uncontrolled perpetuated negative thinking about past stressful life events with a focus on self-referential thought (Nolen-Hoeksema et al., 2008; Papageorgiou, 2006; van Vugt et al., 2018). Consequences of such thinking processes have been shown to render individuals socially unapproachable and uncommunicative as well as unmotivated to engage in remedial behaviours (Nolen-Hoeksema et al., 2008; Papageorgiou, 2006; Watkins, 2008). Additionally, it has been documented that ruminating depletes WM resources in the expense of other tasks (Curci et al., 2013; Whitmer & Gotlib, 2013). Therefore, anxiety-related rumination is a resource-consuming process that might compete with TOM abilities and, thus, interfere with effective coordination.

On the contrary, worry consists of repetitive thinking about mostly external factors such as social and intimate interactions with a more focus on future potential outcomes. Worrisome thinking as opposed to ruminative, has been argued to constitute a problem-solving process that can lead to instrumental behaviours (Papageorgiou, 2006). To illustrate, Zainal & Newman (2018) found that worry in GAD patients increases accuracy in mentalizing abilities. This implies that, when placed in a social environment, worrisome individuals exhibit high motivation to engage in decoding and reasoning of others underlying intentions in order to gain better control over potential future negative outcomes and attenuate personal distress. Furthermore, it has been demonstrated that worry is positively correlated with empathy (Erickson & Newman, 2007), a fundamental component in the development of perspective-taking mentalization (Ibanez et al., 2013; Völlm et al., 2006), while uncorrelated to rumination (Joireman, 2004; Knight et al., 2019).

To experimentally test this, we will induce anxiety-related worry and rumination, explore the mediating role of WM and use hyperscanning for measuring interbrain synchronization (IBS) - as a more potent method of capturing the neural mechanisms underlying social interactions (Astolfi et al., 2011; Minagawa et al., 2018).

Methods



PhD Fund Application form

- *Social Coordination*: pairs of participants will perform the validated TC task as described above.
- *Anxiety Induction*: In this study, we will induce worry and rumination by exposing the participants to text matching typical worrisome and ruminative thinking: e.g., "I am worried I am not going to perform good in the upcoming exams", "I worry about my loved ones' health" and respectively for rumination "Why am I such a loser", "I am in such a bad mood", "Why do bad things happen to me". In the control condition, the text will be unrelated to emotional states, symptoms or the self, e.g. "I like being in the nature", "I prefer tea to coffee". Instructions will include to take time and think about how these statements relate to oneself and judge whether they are personally true or not by pressing a corresponding key.
- *WM Assessment*: For measuring the impact of the anxiety induction on WM at each stage of the experiment and exploring WM's mediating role between anxiety and coordination, the same sentences will be used to assess WM in the form of a reading span task (RST). Participants will be asked to remember the last word of every sentence. Performance will be assessed every 10 trials by asking to recall as many words as possible.
- *Self-report measures*: The same questionnaires as administrated before.
- *Neuroimaging*: EEG hyperscanning.
- *Analysis*: trials will be grouped depending on condition (worry, rumination, control).

Hypothesis

- › We expect that under conditions of rumination as opposed to worry and control participants will less effectively coordinate their actions (lower accuracy) and will take more time to reach a decision (slower reaction times).
- › Worry even though is not expected to significantly interfere with coordinating accuracy, it is anticipated to have increased reaction times as a result of overly thinking others' behavior.
- › WM performance is expected to have a mediating role on the above effects by prioritizing self-referential thinking in rumination and social relevant information in worry.
- › IBS as a neuro-marker of effective interpersonal coordination (Reinero et al., 2021) is expected to decrease in states of ruminative thinking, while possibly unaffected in worry. Previous research showed that more individualistic processes such as thinking about oneself exhibit greater cortical activity in the individual and a corresponding lower IBS between partners (Astolfi et al., 2011).

3rd Study

Given that results from the 2nd study confirm our hypotheses, a third study will focus on the exact role of rumination and examine possible interventions. A core component in rumination is thinking about the self. Maladapting self-reflection, also brooding, refers to recurrent and judgmental thinking about one's self (Nolen-Hoeksema et al., 2008; Trapnell & Campbell, 1999) that significantly interferes with social interactions (Mellings & Alden, 2000; Weaver et al., 2020; Wong & Moulds, 2009). Also, repetitive negative self-thinking has been suggested to compete for cognitive resources with other task-related processes (van Vugt et al., 2018) and negatively affect inhibitory control over WM (Whitmer &



PhD Fund Application form

Banich, 2010, 2010). Provided that negative self-focus is the main factor hampering proper social functioning, we wish to examine how different practices aide people with anxiety-related rumination to be more engaged in social interactions and better coordinate with other individuals.

Therefore, in this study we will examine two different types of interventions by implicitly or explicitly targeting the threaten image of self in ruminative thinking. Firstly, "self-dissolution effect" practices such as mindfulness meditation have been found to reduce symptoms of stress, anxiety and depression, improve inhibition of intrusive thoughts (Gallant, 2016), facilitate prosocial behaviors (Luberto et al., 2018) and exhibit increased IBS (Chen et al., 2021) by indirectly drawing the focus of attention from self to present moment. Secondly, self-compassion practices have been reported to reduce negative affect in ruminators (Oudou & Brinker, 2015; Raes, 2010), improve EF (Harris et al., 2017) and attenuate stress-related rumination (Samaie & Farahani, 2011) by directly enhancing self-acceptance.

Methods

- *Social Coordination*: Again, pairs will perform on the TC twice, prior and post training.
- *4-weeks training*:
 - Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 2005)).
 - Compassion Focused Therapy (CFT; Gilbert, 2009)).
 - Control group – no training.
- *Self-report measures*: Measured prior and post training
 - To test Five-Facets of Mindfulness (FFMQ; Baer et al., 2006)
 - Self-Compassion Scale (SCS; Neff, 2003)
 - STAI & RRS
- Neuroimaging: EEG hyperscanning

Hypothesis

- › We expect pairs after training to better coordinate, an effect that will also be reflected by increased IBS compared to prior-training
- › Additionally, based on the work by Frostadottir & Dorjee (2019), we anticipate CFT to have more broad positive effects on TC regardless of rumination scores, while MBSR to more specifically improve performance in high ruminators.

Knowledge utilization

This work has the potential to critically improve scientific understanding of the underlying mechanisms of anxiety that implicate in social functioning. As a social animal, it is fundamental for humans to be able to efficiently function within the society. Therefore, being able to zoom into specific components of anxiety that hamper social interactions and propose targeted therapeutical plans is of out-most importance. The proposed project will provide important information for scientists and health care providers that can utilize this knowledge and apply cognitive and neural outcomes to their practices. For instance, IBS results could be used in neurofeedback therapies to facilitate self-control while meditation. The ultimate purpose of this project is to alleviate some suffering of many people with anxiety and struggling in their everyday social life.



PhD Fund
 Application form

4c. Word count (sections 4a-4b, max 2000)

2 0 4 7

4d. Time plan and feasibility (max. half a page)

2022 - 2023	Sep – Nov	Dec – Feb	Mar – May	Jun – Aug
Study 1	<ul style="list-style-type: none"> Prepare METC Prepare study 	Data collection	<ul style="list-style-type: none"> Preliminary Data Analysis Decision about change of induction 	Data Analysis
Study 2				Prepare METC
2023 - 2024				
Study 1	Write paper (1)			
Study 2	Prepare study		Data collection	Data Analysis
Start dissertation writing...				
2024 - 2025				
Study 2	Data Analysis		Write Paper (2)	
Study 3	<ul style="list-style-type: none"> Prepare METC Prepare Study 	Data Collection		Data Analysis
dissertation writing ...				
2025 - 2026				
Study 3	Write Paper (3)		Complete dissertation writing	Public Defense & Completion

Delays are to be expected in the preparation of the EEG experiment and data collection of the dyads. EEG preparation and clearance requires substantial time. Additionally, experiment drop-outs or lost data are doubled since both participants data will be needed for the TC and IBS analysis. Finally, in study 3 an intermediate period of one month training is required which may introduce further delays.

4e. Literature references

Astolfi, L., Toppi, J., De Vico Fallani, F., Vecchiato, G., Cincotti, F., Wilke, C., Yuan, H., Mattia, D., Salinari, S., He, B., & Babiloni, F. (2011). Imaging the Social Brain by Simultaneous Hyperscanning during Subject Interaction. *IEEE Intelligent Systems*, 26(5), 38–45. <https://doi.org/10.1109/MIS.2011.61>

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment*, 13(1), 27–45. <https://doi.org/10.1177/1073191105283504>

Bandelow, B., & Michaelis, S. (2015). Epidemiology of anxiety disorders in the 21st century. *Dialogues in Clinical Neuroscience*, 17(3), 327–335.

Bargh, J. A., & Shalev, I. (2012). The Substitutability of Physical and Social Warmth in Daily Life. *Emotion (Washington, D.C.)*, 12(1), 154–162. <https://doi.org/10.1037/a0023527>

Bolton, S., & Robinson, O. J. (2017). The impact of threat of shock-induced anxiety on memory encoding and retrieval. *Learning & Memory*, 24(10), 532–542. <https://doi.org/10.1101/lm.045187.117>

Chaturvedi, K., Vishwakarma, D. K., & Singh, N. (2021). COVID-19 and its impact on education, social life and



PhD Fund
 Application form

- mental health of students: A survey. *Children and Youth Services Review*, 121, 105866.
<https://doi.org/10.1016/j.chidyouth.2020.105866>
- Chen, P., Kirk, U., & Dikker, S. (2021). *Trait mindfulness predicts inter-brain coupling during naturalistic face-to-face interactions* [Preprint]. Neuroscience. <https://doi.org/10.1101/2021.06.28.448432>
- Curci, A., Lanciano, T., Soleti, E., & Rimé, B. (2013). Negative emotional experiences arouse rumination and affect working memory capacity. *Emotion*, 13(5), 867–880. <https://doi.org/10.1037/a0032492>
- Darke, S. (1988). Anxiety and working memory capacity. *Cognition & Emotion*, 2(2), 145–154.
<https://doi.org/10.1080/02699938808408071>
- Dodo, N., & Hashimoto, R. (2017). The effect of anxiety sensitivity on psychological and biological variables during the cold pressor test. *Autonomic Neuroscience: Basic & Clinical*, 205, 72–76.
<https://doi.org/10.1016/j.autneu.2017.05.006>
- Erickson, T. M., & Newman, M. G. (2007). Interpersonal and Emotional Processes in Generalized Anxiety Disorder Analogues During Social Interaction Tasks. *Behavior Therapy*, 38(4), 364–377.
<https://doi.org/10.1016/j.beth.2006.10.005>
- Frostadottir, A. D., & Dorjee, D. (2019). Effects of Mindfulness Based Cognitive Therapy (MBCT) and Compassion Focused Therapy (CFT) on Symptom Change, Mindfulness, Self-Compassion, and Rumination in Clients With Depression, Anxiety, and Stress. *Frontiers in Psychology*, 10, 1099.
<https://doi.org/10.3389/fpsyg.2019.01099>
- Gallant, S. N. (2016). Mindfulness meditation practice and executive functioning: Breaking down the benefit. *Consciousness and Cognition*, 40, 116–130. <https://doi.org/10.1016/j.concog.2016.01.005>
- Gilbert, P. (2009). Introducing compassion-focused therapy. *Advances in Psychiatric Treatment*, 15(3), 199–208.
<https://doi.org/10.1192/apt.bp.107.005264>
- Harris, P. S., Harris, P. R., & Miles, E. (2017). Self-affirmation improves performance on tasks related to executive functioning. *Journal of Experimental Social Psychology*, 70, 281–285.
<https://doi.org/10.1016/j.jesp.2016.11.011>
- Ibanez, A., Huepe, D., Gempp, R., Gutiérrez, V., Rivera-Rei, A., & Toledo, M. I. (2013). Empathy, sex and fluid intelligence as predictors of theory of mind. *Personality and Individual Differences*, 54(5), 616–621.
<https://doi.org/10.1016/j.paid.2012.11.022>
- Joireman, J. (2004). Empathy and the Self-Absorption Paradox II: Self-Rumination and Self-Reflection as Mediators Between Shame, Guilt, and Empathy. *Self and Identity*, 3(3), 225–238.
<https://doi.org/10.1080/13576500444000038>
- Kabat-Zinn, J. (2005). *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness, 15th anniversary ed* (pp. xxxiii, 471). Delta Trade Paperback/Bantam Dell.
- Knight, L. K., Stoica, T., Fogleman, N. D., & Depue, B. E. (2019). Convergent Neural Correlates of Empathy and Anxiety During Socioemotional Processing. *Frontiers in Human Neuroscience*, 13.
<https://doi.org/10.3389/fnhum.2019.00094>
- Lamotte, G., Boes, C. J., Low, P. A., & Coon, E. A. (2021). The expanding role of the cold pressor test: A brief history. *Clinical Autonomic Research*, 31(2), 153–155. <https://doi.org/10.1007/s10286-021-00796-4>
- Leslie, A. M., Friedman, O., & German, T. P. (2004). Core mechanisms in “theory of mind.” *Trends in Cognitive Sciences*, 8(12), 528–533. <https://doi.org/10.1016/j.tics.2004.10.001>
- Luberto, C. M., Shinday, N., Song, R., Philpotts, L. L., Park, E. R., Fricchione, G. L., & Yeh, G. Y. (2018). A Systematic Review and Meta-analysis of the Effects of Meditation on Empathy, Compassion, and Prosocial Behaviors. *Mindfulness*, 9(3), 708–724. <https://doi.org/10.1007/s12671-017-0841-8>
- Mellings, T. M. B., & Alden, L. E. (2000). Cognitive processes in social anxiety: The effects of self-focus, rumination and anticipatory processing. *Behaviour Research and Therapy*, 38(3), 243–257.
[https://doi.org/10.1016/S0005-7967\(99\)00040-6](https://doi.org/10.1016/S0005-7967(99)00040-6)
- Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy*, 28(6), 487–495.
[https://doi.org/10.1016/0005-7967\(90\)90135-6](https://doi.org/10.1016/0005-7967(90)90135-6)
- Minagawa, Y., Xu, M., & Morimoto, S. (2018). Toward Interactive Social Neuroscience: Neuroimaging Real-World Interactions in Various Populations. *Japanese Psychological Research*, 60(4), 196–224.
<https://doi.org/10.1111/jpr.12207>



PhD Fund
Application form

- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “Frontal Lobe” tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. <https://doi.org/10.1006/cogp.1999.0734>
- Mohammadi, M. R., Pourdehghan, P., Mostafavi, S.-A., Hooshiyari, Z., Ahmadi, N., & Khaleghi, A. (2020). Generalized anxiety disorder: Prevalence, predictors, and comorbidity in children and adolescents. *Journal of Anxiety Disorders*, *73*, 102234. <https://doi.org/10.1016/j.janxdis.2020.102234>
- Moran, T. P. (2016). Anxiety and working memory capacity: A meta-analysis and narrative review. *Psychological Bulletin*, *142*(8), 831–864. <https://doi.org/10.1037/bul0000051>
- National Institute of Mental Health. (n.d.). *Any Anxiety Disorder*. Retrieved August 18, 2021, from <https://www.nimh.nih.gov/health/statistics/any-anxiety-disorder>
- Neff, K., D. (2003). The Development and Validation of a Scale to Measure Self-Compassion. *Self and Identity*, *2*(3), 223–250. <https://doi.org/10.1080/15298860309027>
- Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking Rumination. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *3*(5), 400–424. <https://doi.org/10.1111/j.1745-6924.2008.00088.x>
- Odou, N., & Brinker, J. (2015). Self-compassion, a better alternative to rumination than distraction as a response to negative mood. *The Journal of Positive Psychology*, *10*(5), 447–457. <https://doi.org/10.1080/17439760.2014.967800>
- Oei, N. Y. L., Everaerd, W. T. A. M., Elzinga, B. M., Well, S. van, & Bermond, B. (2006). Psychosocial stress impairs working memory at high loads: An association with cortisol levels and memory retrieval. *Stress*, *9*(3), 133–141. <https://doi.org/10.1080/10253890600965773>
- Papageorgiou, C. (2006). Worry and Rumination: Styles of Persistent Negative Thinking in Anxiety and Depression. In *Worry and its Psychological Disorders* (pp. 21–40). John Wiley & Sons, Ltd. <https://doi.org/10.1002/9780470713143.ch2>
- Perner, J., & Lang, B. (1999). Development of theory of mind and executive control. *Trends in Cognitive Sciences*, *3*(9), 337–344. [https://doi.org/10.1016/S1364-6613\(99\)01362-5](https://doi.org/10.1016/S1364-6613(99)01362-5)
- Raes, F. (2010). Rumination and worry as mediators of the relationship between self-compassion and depression and anxiety. *Personality and Individual Differences*, *48*(6), 757–761. <https://doi.org/10.1016/j.paid.2010.01.023>
- Reinero, D. A., Dikker, S., & Van Bavel, J. J. (2021). Inter-brain synchrony in teams predicts collective performance. *Social Cognitive and Affective Neuroscience*, *16*(1–2), 43–57. <https://doi.org/10.1093/scan/nsaa135>
- Robinson, O. J., Vytal, K., Cornwell, B. R., & Grillon, C. (2013). The impact of anxiety upon cognition: Perspectives from human threat of shock studies. *Frontiers in Human Neuroscience*, *7*, 203. <https://doi.org/10.3389/fnhum.2013.00203>
- Samaie, Gh., & Farahani, H. A. (2011). Self-compassion as a moderator of the relationship between rumination, self-reflection and stress. *Procedia - Social and Behavioral Sciences*, *30*, 978–982. <https://doi.org/10.1016/j.sbspro.2011.10.190>
- Schelling, T. C. (1960). *The Strategy of Conflict*. Harvard University Press.
- Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology*, *76*(2), 284–304. <https://doi.org/10.1037/0022-3514.76.2.284>
- Treynor, W. (2003). Rumination Reconsidered: A Psychometric Analysis. *Cognitive Therapy and Research*, *27*(3), 247–259. <https://doi.org/10.1023/A:1023910315561>
- van Vugt, M. K., van der Velde, M., & ESM-MERGE Investigators. (2018). How Does Rumination Impact Cognition? A First Mechanistic Model. *Topics in Cognitive Science*, *10*(1), 175–191. <https://doi.org/10.1111/tops.12318>
- Völlm, B. A., Taylor, A. N. W., Richardson, P., Corcoran, R., Stirling, J., McKie, S., Deakin, J. F. W., & Elliott, R. (2006). Neuronal correlates of theory of mind and empathy: A functional magnetic resonance imaging study in a nonverbal task. *NeuroImage*, *29*(1), 90–98. <https://doi.org/10.1016/j.neuroimage.2005.07.022>
- Watkins, E. R. (2008). *Constructive and unconstructive repetitive thought*. Psychological Bulletin; US:



**PhD Fund
 Application form**

American Psychological Association. <https://doi.org/10.1037/0033-2909.134.2.163>

Weaver, S., O’Shannessy, D., & Donovan, C. (2020). Rumination and Worry. In *The Encyclopedia of Child and Adolescent Development* (pp. 1–11). American Cancer Society. <https://doi.org/10.1002/9781119171492.wecad164>

Weymar, M., Bradley, M. M., Hamm, A. O., & Lang, P. J. (2013). When fear forms memories: Threat of shock and brain potentials during encoding and recognition. *Cortex; a Journal Devoted to the Study of the Nervous System and Behavior*, *49*(3), 819–826. <https://doi.org/10.1016/j.cortex.2012.02.012>

Whitmer, A. J., & Banich, M. T. (2010). Trait rumination and inhibitory deficits in long-term memory. *Cognition and Emotion*, *24*(1), 168–179. <https://doi.org/10.1080/02699930802645762>

Whitmer, A. J., & Gotlib, I. H. (2013). An attentional scope model of rumination. *Psychological Bulletin*, *139*(5), 1036–1061. <https://doi.org/10.1037/a0030923>

Wong, Q. J. J., & Moulds, M. L. (2009). Impact of rumination versus distraction on anxiety and maladaptive self-beliefs in socially anxious individuals. *Behaviour Research and Therapy*, *47*(10), 861–867. <https://doi.org/10.1016/j.brat.2009.06.014>

Wu, T., Luo, Y., Broster, L. S., Gu, R., & Luo, Y. (2013). The Impact of Anxiety on Social Decision-Making: Behavioral and Electrodermal Findings. *Social Neuroscience*, *8*(1), 11–21. <https://doi.org/10.1080/17470919.2012.694372>

Zainal, N. H., & Newman, M. G. (2018). Worry amplifies theory-of-mind reasoning for negatively valenced social stimuli in generalized anxiety disorder. *Journal of Affective Disorders*, *227*, 824. <https://doi.org/10.1016/j.jad.2017.11.084>

Zhong, C.-B., & Leonardelli, G. J. (2008). Cold and Lonely: Does Social Exclusion Literally Feel Cold? *Psychological Science*, *19*(9), 838–842.

PHD CANDIDATE, SUPERVISION AND SETTING

5. Candidate’s CV

Bachelor study (studies)			
University	Panteion University	Department	Psychology
Name BA study	Psychology		
Specialisation	--		
Thesis title	"The interplay of dynamic gaze and emotion on time estimation"		
Thesis grade	8		



PhD Fund
 Application form

Date diploma	03/02/2018	Distinction	First Honor's Degree
Start date	09/2013	End date	02/2018
Average weighted grade based on ECs	8.84 / 10		
Honour or talent programme	--		
Start date	-	End date	-
Average weighted grade based on ECs	Grade:-	Distinction	-
Research master			
Start date	09/2018	End date	08/2021
Subjects	Master's Research Project 2: Effects of working memory load on tacit coordination and inter-brain synchrony BCN Summer Symposium 2 Philosophy of Neuroscience Master's Research Project 1: The effect of dynamic emotional context on perceived durations Human Neuroanatomy Advanced Statistics Auditory and Visual Perception BCN Summer Symposium 1 Colloquium Career Related Topics Cognitive Neuropsychiatry Repeated Measures Introduction to the Behavioural and Cognitive Neurosciences Models of Cognition Functional Neuroscience Repeated Measures		



PhD Fund
 Application form

Specialisation	Cognitive Neuroscience
Graduation date	TBA
Title thesis	Effects of working memory load on tacit coordination and inter-brain synchrony
Average weighted grade based on ECs	TBA
	Grade: TBA
Prizes, awards	-
Extracurricular activities (max. 200 words)	
Academic activities	<p>Certifications & Workshops</p> <ul style="list-style-type: none"> > 2020_Neuromatch Academy: Online summer school on Computational Neuroscience > 2018_Human Brain Project: Neurobiology for non-specialists- Understanding the Brain, Medical University Innsbruck, Austria > 2015 – 2016_Clinical Psychopathology: Annual Educational program Sismanogleio General Hospital, Athens, Greece <p>Poster and Talk Presentations:</p> <ul style="list-style-type: none"> > Christodoulou, A., Maass, S. C., & van Rijn, H. (2019). The effect of dynamic emotional context on perceived duration. Poster presented at the 17th NVP winter conference on Brain & Cognition Egmond aan Zee, Netherlands. > Christodoulou, A., & Vatakis, A. (2018). The interplay of dynamic gaze and emotion on time estimation. Talk presented at the 5th Panhellenic Conference on Cognitive Science, Paros, Greece. <p>Research Assistant on the following projects:</p> <ul style="list-style-type: none"> > Exploring how more naturalistic manifestations of threat in lab studies can affect time perception (2020) > Assisting in the design and implementation of an eye-tracking study on prolonged grief (2020) > Examining the effects of covertly attending to blue or red light on the pupil light response. (2019)



PhD Fund
 Application form

) Exploring the effects of cinematography cuts on one's percept of a scene's duration (2017)
Non-academic activities	

FINANCIAL DETAILS

6. Budget

Personnel	
PhD student	4 years full time, plus 10k€ lump sum for the project
<p>If this section is left empty, this means that the applicant expects the costs of the project not to exceed the 10k€ lump sum available for PhD related costs (e.g., conferences, education, research costs, including knowledge exchange, impact, data management, data collection etc.).</p> <p>Only if the project is expected to exceed 10k€, the applicant is required to indicate how this surplus will be covered by specifying the expected costs below.</p>	
PhD related costs (please specify)	In k€

STATEMENTS

7. Statements by the Applicant

~~TRUE/FALSE~~ The relevant director of research¹ (of either Psychology, Sociology, or Educational Science) has been informed and agrees to accept the conditions if the proposal is awarded a grant.

~~TRUE/FALSE~~ I have completed this form truthfully.

¹ Psychology: prof. dr. Peter de Jonge / Sociology: prof. dr. René Veenstra / PedOn: prof. dr. Roel Bosker



PhD Fund Application form

Name: Aikaterini (Katerina) Christodoulou

Place: Groningen

Date: **27/08/2021**

DATA MANAGEMENT

Data management

Responsible data management is part of good research. For the collection/generation of data and the analysis of these data timely measures need to be taken to ensure its storage and later reuse. This means that prior to the start of the research project researchers must ascertain a) if the project can make use of available data from third parties, b) which project data could be relevant for reuse and c) how these data can be stored so that they are suitable for reuse.

After a proposal has been awarded funding the researcher will draw up a detailed data management plan.

Deadline for submitting this form: ---

Please submit the application to the Graduate School of Behavioural and Social Sciences in pdf format (gradschool.bss@rug.nl). The application must be submitted from the account of one of the applicants mentioned under question 1.