Investigating the relationship between reward prediction and learning

Start of Block: Information Sheet

Q1   
 **INVESTIGATING THE RELATIONSHIP BETWEEN REWARD PREDICTION AND LEARNING**  
    
 You are being invited to take part in an online research study which will constitute a part of a PhD dissertation. Before you decide to take part, it is important for you to understand why the research is being carried out and what it will involve. Please take time to read the following information carefully and decide whether you wish to participate. If anything is unclear, please contact the researcher:  
    
 Margherita Tecilla <**mteci003@gold.ac.uk**>  
 or Dr Maria Herrojo-Ruiz <**M.Herrojo-Ruiz@gold.ac.uk**> for clarification.   
    
 Thank you for reading this.  
   
 **What is the purpose of the study?**  
 The aim of the study is to understand how reward anticipation influences motor learning in young (<40 years old) and healthy ageing (>60 years old). We are also interested in exploring how additional factors (such as anxiety) might mediate the relationship between reward prediction and learning.   
   
 **Who can take part?**  
 You must be over 18 to participate and be either younger that 40 years old or older than 60 years old.   
 If you are 40 years old or younger you will be allocated to the young group. If you are 60 years old or older you will be allocated to the aging group.   
 All participants must have normal or corrected vision and be able to perform controlled finger movements.   
 This study is not permitted to work with individuals clinically diagnosed with movement disorders and/or mental health conditions and with amateur/professional pianists.  This study must be completed using a computer/laptop and a keyboard - it is not compatible with Smartphones/iPads.   
 **What will happen to me if I take part?**  
 You will be asked to provide some demographic information, to fill out a 20-question anxiety questionnaire and to complete a reward-based motor sequence learning task. As far as the anxiety questionnaire is concerned, we ask you to reply to all items. However, if you do not want to provide an answer you are free to interrupt participation in the study. To accomplish the task, you will be requested to perform motor sequences by using your computer keyboard in order to get a reward.   
 The study duration amounts to approximately 30 min.   
   
 **Do I have to take part?**  
 Participation is entirely voluntary. If you decide to take part, you are still free to withdraw at any time and without giving a reason.  
   
 **What are the possible disadvantages and risks of taking part?**  
 There is no significant discomfort anticipated as a result of taking part in this study. If you feel uncomfortable at any time during the study, you are free to withdraw. This study was approved by the Goldsmiths' Psychology Ethics Committee.   
 However, keep in mind that the anxiety questionnaire will ask you to potentially recall negative experiences to measure anxiety. Please understand that whilst you have a right to request your data, this should not be treated like a professional clinical diagnosis.   
 If you feel worried about the thoughts/feelings/behaviour you are experiencing, but are not in a crisis, please call 116 123 to talk to Samaritans, or email: jo@samaritans.org for a reply within 24 hours. Text "SHOUT" to 85258 to contact the Shout Crisis Text Line. If you are experiencing a crisis and need urgent mental health support find a local health helpline: <https://www.nhs.uk/service-search/mental-health/find-an-urgent-mental-health-helpline>.  
   
   
    
 **What are the possible benefits of taking part?**  
 There are not anticipated benefits as a result of participating in this study.   
 However, if you are interested, you may contact the student project researcher to be informed about the study results. Your results contribute towards more valid understanding of how anticipating reward modulates motor sequence learning.   
 This task has been designed to also investigate motor learning processes in Parkinson’s Disease patients. Your contribution as a healthy participant will therefore help us to understanding the mechanisms that modulate predictive processing of motor rewards in Parkinson’s Disease patients and would thus allow us to delineate interventions by regulating and refining those processes to improve motor learning.  
   
 **What if something goes wrong?**  
 If you wish to complain about the experience you have had, please contact the Supervisor <**M.Herrojo-Ruiz@gold.ac.uk**> or the Chair of the Research Ethics Committee <**y.kovas@gold.ac.uk**>  
   
 **Will my taking part in this study be kept confidential?**  
 All information which is collected about you during the course of the research will be kept strictly confidential.  
   
 **What will happen to the results of the research study?**  
 The results of the research will be written up as part of a postgraduate dissertation and will be used for publications. The data will not be attached to you or identifiable in any way.  
   
 **Who has reviewed the study?**  
 The study has been reviewed by the Research Ethics Committee at Goldsmiths, University of London.  
   
 **Passage on Research Integrity**  
 Goldsmiths, University of London, is committed to compliance with the Universities UK Research Integrity Concordat. You are entitled to expect the highest level of integrity from our researchers during the course of their research.  
    
 **Contact for Further Information and Complaints**  
 Experimenter:  
 Margherita Tecilla <**mteci003@gold.ac.uk**>,  
    
 Supervisor:  
 Dr Maria Herrojo-Ruiz <**M.Herrojo-Ruiz@gold.ac.uk**>  
   
   
    
 

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Q2   
   
**General Data Protection Regulations (GDPR)**   
  
 Goldsmiths full GDPR policy for research can be downloaded here [[GDPR - pdf](https://drive.google.com/file/d/17Ox3yer4pdRc6rV7e4CLTTcd8iB6NwvF/view?usp=sharing)]  
     
To comply with GDPR we will not collect any information that can personally identify you such as your name or IP address. All data are collected anonymously. However, we also want you to be able to withdraw your data if you change your mind about the study. Therefore we ask you to create an identifying code known only to you   
    
**Write down the last three letters of your mother's maiden name and your month of birth (e.g. LIK09)**

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Q41 **Participation Prize**   The monetary compensation amounts to up to £10. You will receive a minimum rate of £5, but you can additionally receive £5 depending on task performance (total £10). The better you perform, the greater the total compensation you will get.   
You must have a UK bank account in order to receive the prize.    
    
   
Once completed the online experiment, you must email Margherita Tecilla <**mteci003@gold.ac.uk**> with the following information in order to receive your monetary reward:    
  
 - the anonymous **GDPR code** you used above (last three letters of your mother's maiden name and your month of birth, i.e. LIK09)  
 - your **full name**  
 - your **email address**  
 - your **phone number**   
    
This information will not be included on the study database which will be fully anonymized.   
   
 Your email address and mobile phone number will be used by the NatWest Payit™; Send Money  service so that they can make the payment to you. You’ll need to provide NatWest Payit™; Send Money  with your bank account number and sort code directly which they will use to make the payment. You have rights in relation to how NatWest processes this information. If you would like more information on this and your rights, please visit https://sendmoney.natwest.co.uk/sendmoney/privacy This is also available to you as part of the claim journey.

End of Block: Information Sheet

Start of Block: Consent

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Q3 Tick**all boxes** below to declare you consent to take part in the study:

* I am 18 or over (6)
* I understand that I will not be referred to by name in any report concerning the study (4)
* I understand I am free to withdraw from the study at any time and without having to give a reason for withdrawing (5)
* I consent to take part in this study (1)

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Q41 Click to write the question text

Browser (1)

Version (2)

Operating System (3)

Screen Resolution (4)

Flash Version (5)

Java Support (6)

User Agent (7)

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End of Block: Consent

Start of Block: Inclusion criteria check

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Q14 In order to take part in the study you need to tick **all** boxes below:

* I am either younger than 40 years old or older than 60 years old (5)
* I am not diagnosed with a movement disorder (e.g. Parkinson's disease, Huntington disease) and I am able to perform controlled finger movements (6)
* I do not have mental health conditions (7)
* I have normal or corrected vision (8)
* I am not an amateur/professional pianist (9)
* I am right handed (10)

End of Block: Inclusion criteria check

Start of Block: Block 7

Q38 Do you consent to your anonymised performance data to be uploaded to an open repository (e.g. Open Science Framework?  
Performance data refers to the data collected during the motor task. In any case, no personal/demographic/survey data will be uploaded.

* Yes (1)
* No (2)

End of Block: Block 7

Start of Block: Demographics

Q8 How old are you?

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Q9 What is your gender?

▼ Female (1) ... Prefer not to say (4)

Q10 What is your ethnicity?

▼ White/Welsh/Scottish/Northern Irish (4) ... Other (20)

End of Block: Demographics

Start of Block: STAI X-2

Q15 A number of statements which people have used to describe themselves are given below. Read each statement and then tick the appropriate circle to the right of the statement to indicate how you **generally** feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

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|  | Almost never (1) | Sometimes (2) | Often (3) | Almost always (4) |
| I feel pleasant (1) |  |  |  |  |
| I tire quickly (2) |  |  |  |  |
| I feel like crying (3) |  |  |  |  |
| I wish I could be as happy as others seem to be (4) |  |  |  |  |
| I am losing out on things because I can't make up my mind soon enough (5) |  |  |  |  |
| I feel rested (6) |  |  |  |  |
| I am "calm, cool, and collected" (7) |  |  |  |  |
| I feel that difficulties are piling up so that I cannot overcome them (8) |  |  |  |  |
| I worry too much over something that really doesn't matter (9) |  |  |  |  |
| I am happy (10) |  |  |  |  |
| I am inclined to take things hard (11) |  |  |  |  |
| I lack self-confidence (12) |  |  |  |  |
| I feel secure (13) |  |  |  |  |
| I try to avoid facing a crisis or difficulty (14) |  |  |  |  |
| I feel blue (15) |  |  |  |  |
| I am content (16) |  |  |  |  |
| Some unimportant thought runs through my mind and bothers me (17) |  |  |  |  |
| I take disappointments so keenly that I can't put them out of my mind (18) |  |  |  |  |
| I am a steady person (19) |  |  |  |  |
| I get in a state of tension or turmoil as I think over my recent concerns and interests (20) |  |  |  |  |

End of Block: STAI X-2

Start of Block: Experiment

Q34 We are now ready to start with the motor learning task!  
   
  
   
First of all, please make sure the Caps Lock key (the one you use to switch from lower to upper case letters) on your computer keyboard is not enabled.   
  
  
In a first phase you will learn how to play two short sequences using your computer keyboard.    
    
In the second phase, at each round you will be asked to play **one of the two** memorized sequences in order to get a reward (10 points). Your aim is to collect as many points as possible, therefore choose and play the sequence you think is more likely to give you a reward.    
**Note that the points associated with each sequence will change time to time. Hence, one sequence could be rewarding in one trial, but could give you 0 points in the following round. So pay attention and adapt if you think the conditions changed.**   
Do not worry, you will be walked through these stages step by step.    
    
Let's now check if you understood how the experiment works...

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Q35 At each attempt, I have to:

* play only one sequence (1)
* play both sequences (2)
* I do not know (3)

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Q36 At each attempt, on what basis do I decide which sequence to play?

* I play the sequence I like the most (1)
* I play the easiest sequence (3)
* I play the sequence I think is more likely to be rewarding (2)
* I do not know (4)

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Q37   
 One sequence is **always** more rewarding than the other, regardless of the round. Therefore, in order to collect the highest amount of points I need to play the same sequence over and over throughout the experiment.

* True (1)
* False (2)

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<The Training and Main Phase of the Experiment takes place here>

Q22

End of Block: Experiment

Start of Block: Debrief

Q16 **THE END!**We would like to take this opportunity to say **Thank You** for taking the time to complete our study.   Please be assured, all data collected will be treated in the strictest confidence. You are free to withdraw your data from the research at any time by contacting Margherita Tecilla <mteci003@gold.ac.uk> or Supervisor Dr Maria Herrojo-Ruiz <M.Herrojo-Ruiz@gold.ac.uk>.  The overarching goal of this project is to understand how update of reward predictions modulates motor behaviour and motor learning in young and older participants.  This is motivated by the observation that reward-based learning relies on the dopaminergic activity of neurons in the brain. Critically, ageing is characterised by a reduced dopaminergic neurotransmission, which is thought to account for the observed reduced sensitivity to reward signals in later stages of life. Incentives are crucial for learning and motor control. For instance, an enhancement in movement accuracy and speed of actions can be achieved by introducing monetary compensations. Furthermore, rewards act via increasing motor motivation, thus influencing the likelihood to compute effortful actions, and dopamine seems to be the key neuromodulator in regulating this motivational effect.  On these bases, we want to test the hypothesis that older participants, who are characterised by reduced levels of dopamine in the brain, will fail to properly integrate reward signals into an ongoing model of the action-outcome associations. The reduced sensitivity to reward predictions will therefore lead to a decreased learning of the motor actions associated with potential future rewards. We are also interested in understanding what the role of anxiety in reward-based learning processes is. This is driven by the observation that anxiety has negative influences on a broad range of motor and cognitive processes such as learning. We therefore expect that those scoring higher in the anxiety questionnaire will show a reduced ability to learn from feedback and therefore will display a worse motor performance in the sequence learning task.  This behavioural study is intended to guide our future experiments looking at understanding the neurophysiological mechanisms mediating the link between reward prediction and motor learning. To achieve this goal, we will use the very same task in combination with neuroscientific techniques (EEG, TMS, EMG) to examine the changes in cortical oscillations and motor cortex excitability as a function of reward expectations.  Not only this task will be administered to healthy participants, but also to Parkinson’s Disease (PD) patients. The hallmark of PD is a loss of dopamine cells in deep brain regions leading to a severe decline in motor functioning, with tremor, bradykinesia and rigidity among the most common symptoms. Besides the prominent motor deficits, PD patients also report several cognitive impairments, including an aberrant sensitivity to reward signals that guide learning. Understanding the mechanisms that modulate predictive processing of motor rewards in PD would thus allow us to delineate interventions by regulating and refining those processes to improve motor learning. If you were unduly or unexpectedly affected by taking part in the study please feel free to feed it back to the researcher. If you feel unable for whatever reason what-so-ever to talk with the researcher then please either contact Supervisor < **m.herrojo-ruiz@gold.ac.uk**> or the Head of Psychology. Moreover, in case the anxiety questionnaire caused you distress and you want to seek professional support, the following services may be of interest to you: Mind.org or Samaritans.org.    
We remind you that if you feel worried about the thoughts/feelings/behaviour you are experiencing, but are not in a crisis, please call 116 123 to talk to Samaritans, or email: jo@samaritans.org for a reply within 24 hours. Text "SHOUT" to 85258 to contact the Shout Crisis Text Line. If you are experiencing a crisis and need urgent mental health support find a local health helpline: https://www.nhs.uk/service-search/mental-health/find-an-urgent-mental-health-helpline.

End of Block: Debrief