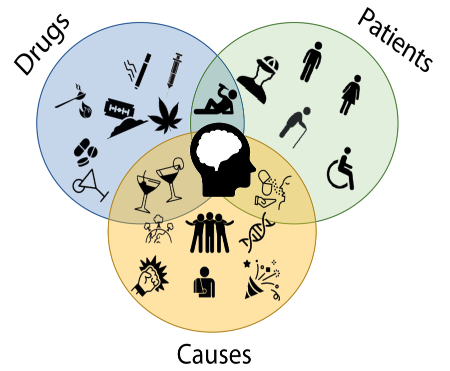
Towards a new dimensional approach to addiction: linking addiction markers to the connectivity profiles of the striatum subdivisions

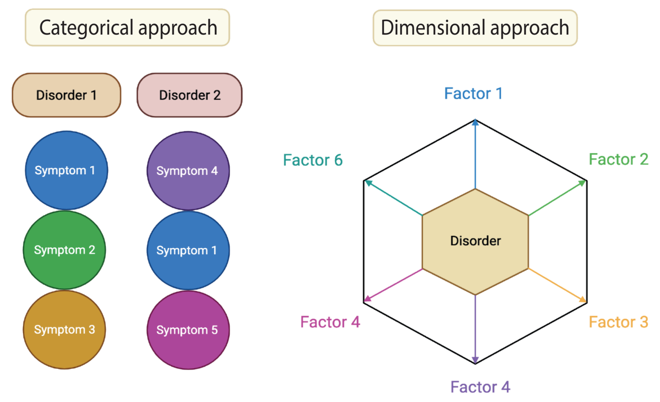
Kenza Kadri[1*], Siti Yaakub[1], Jacqueline Scholl[2], Billy Hosking[1], Mica Komarnyckyj[3], Matthew Rushworth[2], Miriam Klein-Flugge[2], Elsa Fouragnan[1]

[1] School of Psychology, University of Plymouth, UK
[2] Wellcome Integrative Neuroimaging (WIN), Department of Experimental Psychology, University of Oxford, Oxford, UK
[3] Centre for Cognition and Neuroscience, University of Huddersfield, UK

Introduction



Addiction is a complex disease

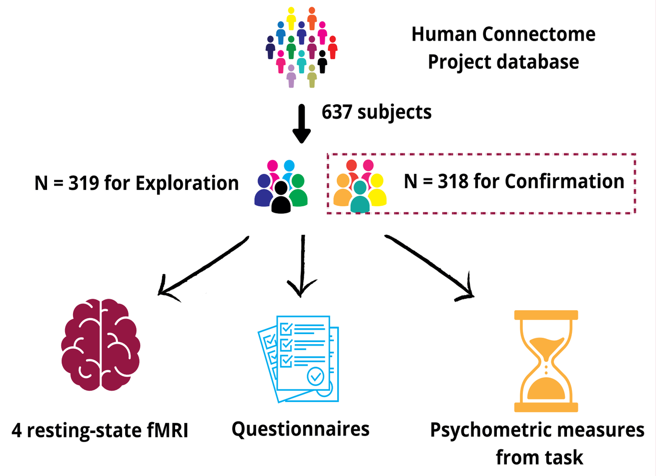


Use of an integrative method

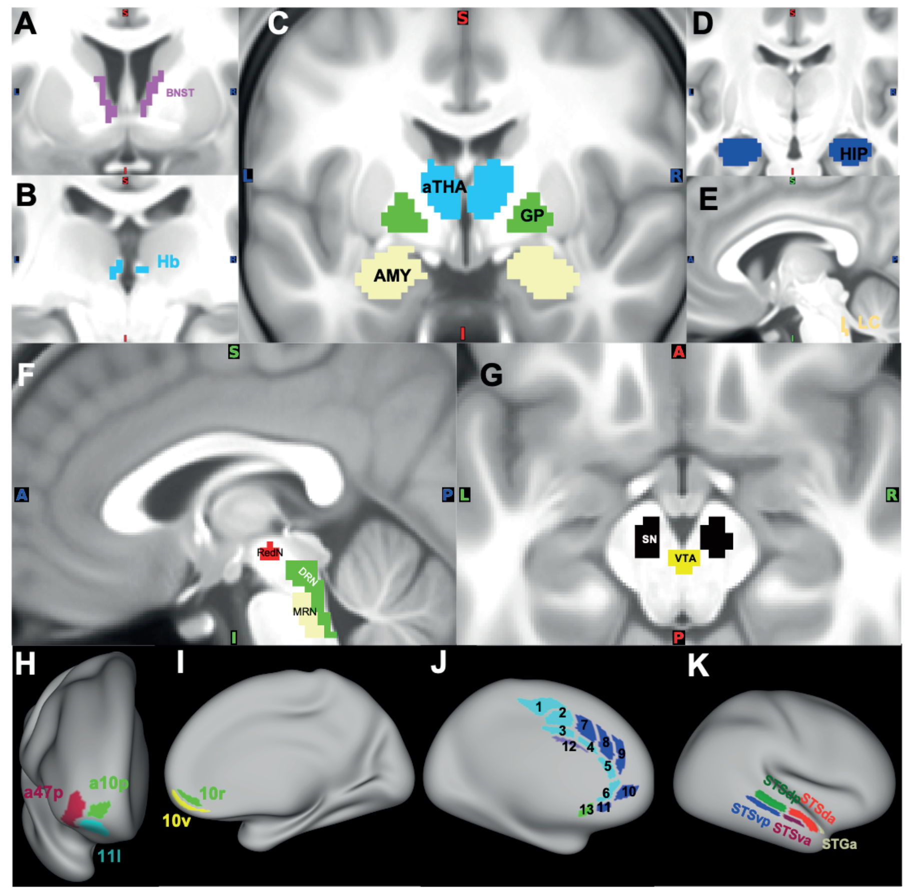
Aims & Methods

Linking the connectivity profiles of the striatum with behavioural features related to addiction

- Capitalize on big data to look for behavioral markers associated with addiction (with Factor Analysis & computational model)
- Look at the strength of connectivity between subregions of the striatum and other Prefrontal cortex regions, Temporal regions and Subcortical regions in relationship to these behavioral markers (with rsMRI data).



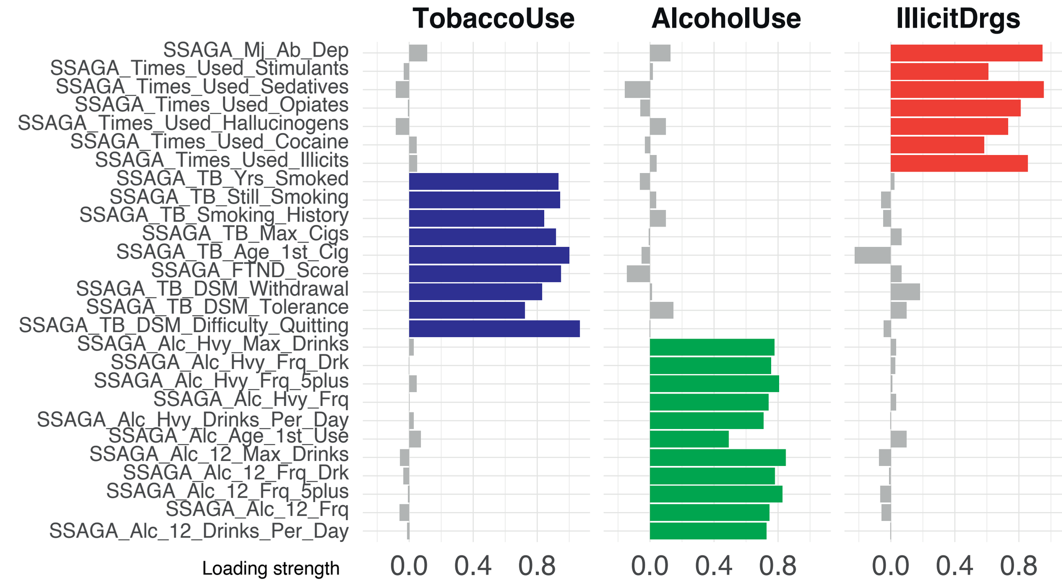
Multiple ROIs



A-G) Subcortical and I-K) cortical masks. A) BNST = Bed Nucleus of the Stria Terminalis B) Hb = Habenula C) aTHA = anterior thalamus, GP = Globus Pallidus, AMY = amygdala D) HIP = Hippocampus E) LC = Locus Coeruleus F) RedN = Red nucleus, DRN = dorsal Raphe Nucleus, MRN = median raphe nucleus and G) SN = Substantia nigra and VTA = Ventral Tegmental Area. Cortical area H) the 3 areas belong to the OFC. I) Both areas are part of the vmPFC. J) Anterior Cingulate cortex with 1=24dd, 2=24dv, 3=p24pr, 4=a24pr, 5=p25, 6=a24, 7=p32pr, 8a32pr, 9=d32, 10=p32, 11=s32, 12=33pr and 13 = 25. K) Superior Temporal Sulcus (STS) is divided into a ventroposterior part (STSvp), a dorso-posterior (STSdp), a dorso-anterior (STSda) and a ventro-anterior (STSva). Adjacent to the STS, we selected the anterior part of the Superior Temporal Gyrus (STGa)

To investigate addiction biomarkers related to the striatum subdivision, we selected 36 regions of interest (ROIs) prior to any analysis. These ROIs are known to be 1) anatomically connected to the striatum 2) functionally connected to the striatum (e.g., dopaminergic neurons) or 3) implicated more broadly in reward-related decision making.

Extraction of 3 latent behaviours

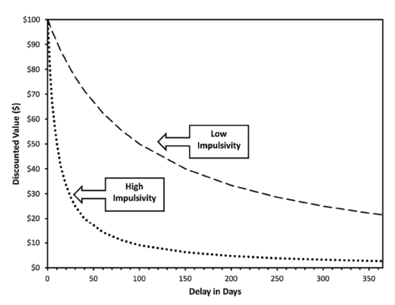


We extracted 3 factors from our 27 questionnaires, i) TobaccoUse, ii) AlcholUse and iii) Illicit drug use. The three factors were used to extract latent behaviours for all of our participants.

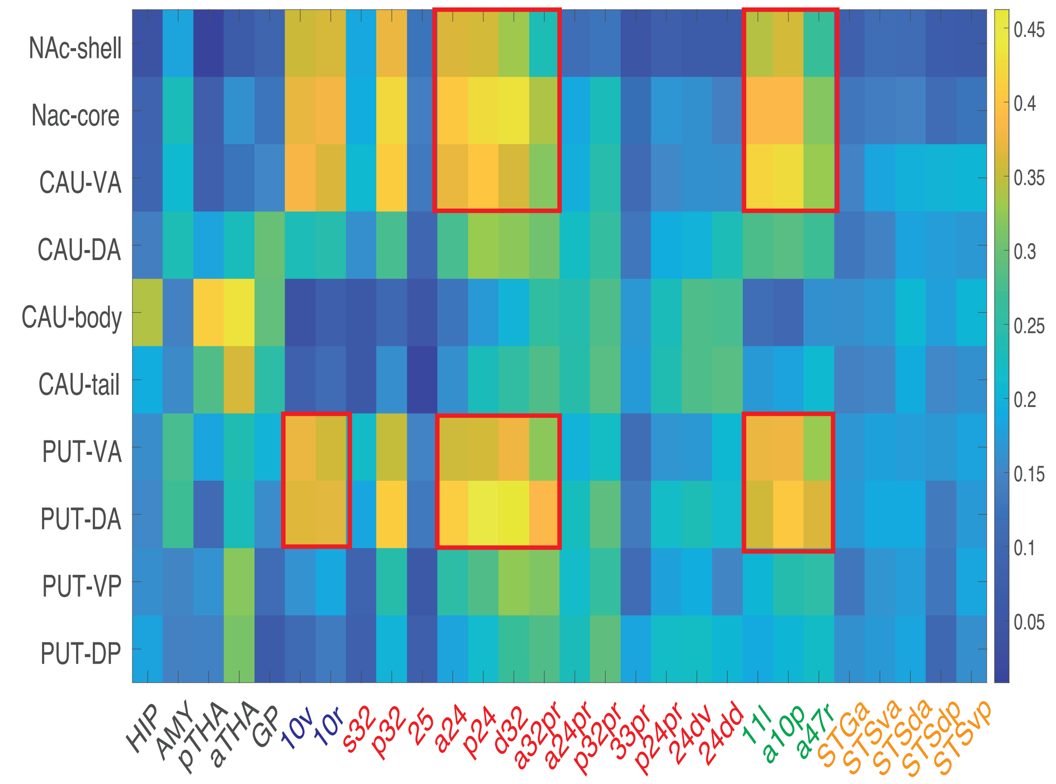
Extraction of an impulsivity score

We also extracted an impulsivity score consisting of the average of the area under the curve for 2 magnitudes of reward ($200 & $40k) as well as the discounting factor k fitted according to the following formula.

$$V = \frac{A}{1 + Kd}$$



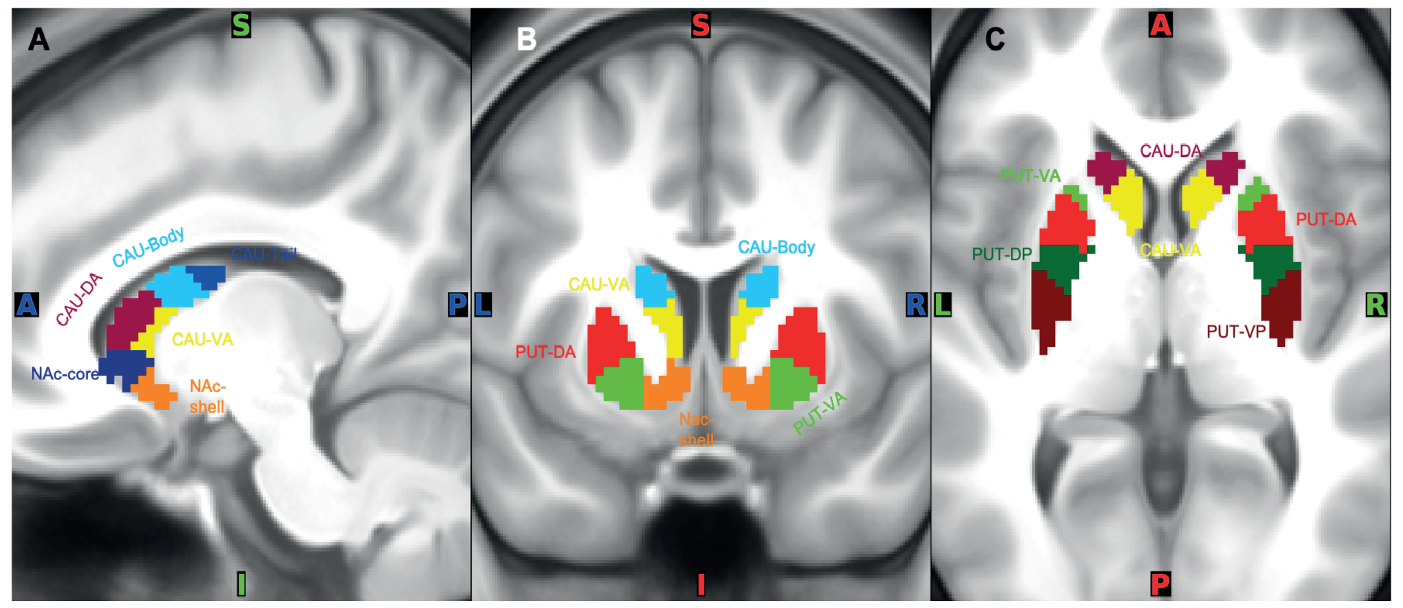
Resting-State Functional Connectivity



Strength of mean functional coupling (n=318)

Strong connectivity of the Putamen and Nucleus Accumbens to the ventro-median prefrontal cortex, the orbitofrontal cortex and the anterior cingulate cortex as per litterature (Pisauro et al., 2017; Morgenstern et al., 2013; Whittaker et al., 2018)

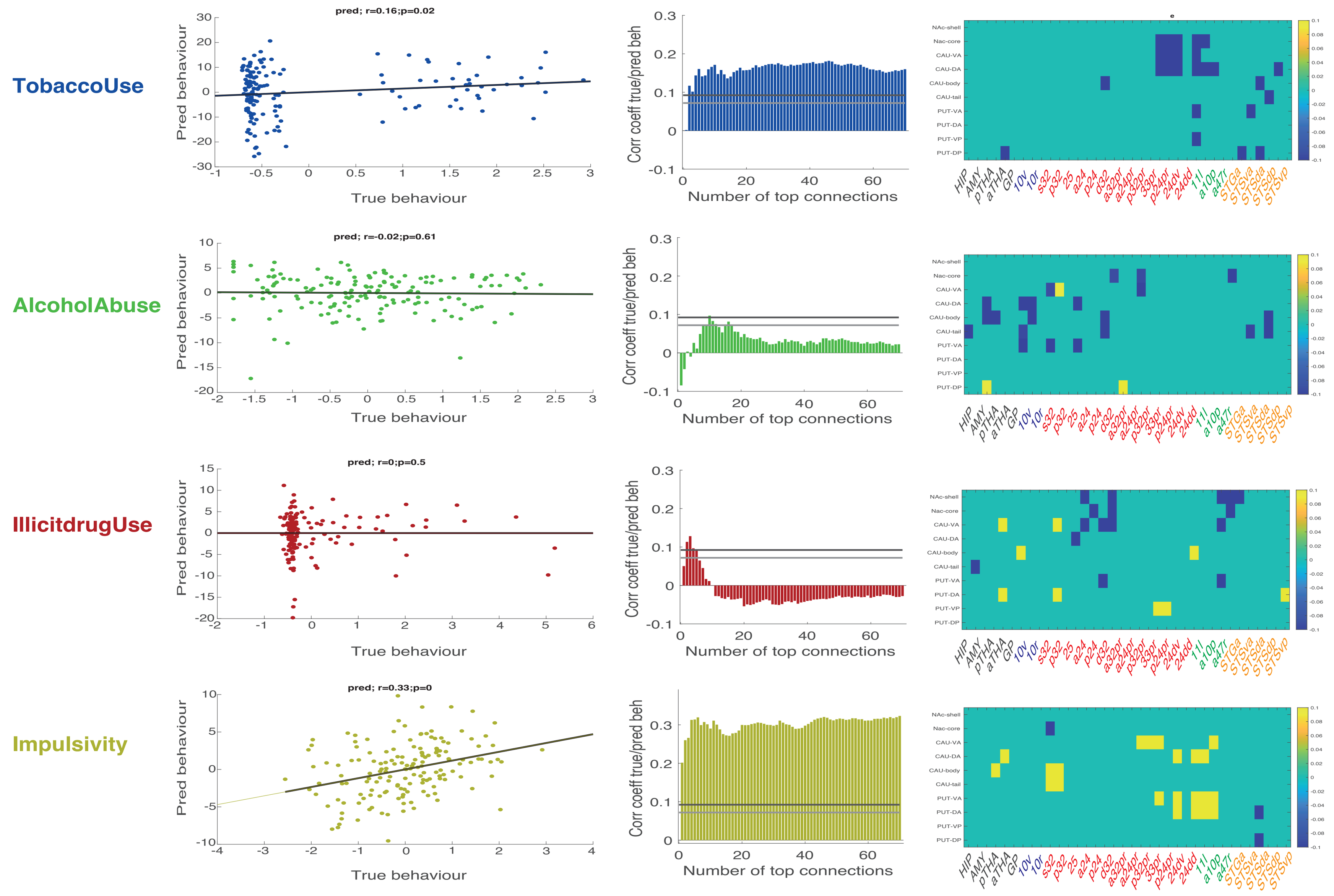
The striatum: a major hub in addiction



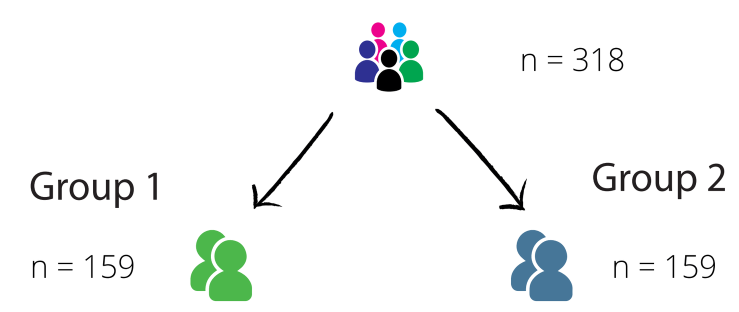
The striatum divided into 10 adjacent subdivisions accordingly to Tian et al, 2020 on A) Sagittal view B) Coronal view and C) Axial view. Each mask is extracted and binarized from Tian et al parcellation. NAc = Nucleus Accumbens, PUT = Putamen and CAU = Caudate nucleus. Subregions are named according to their respective position, DA = Dorso-anterior, VA = Ventro-anterior, DP = Dorso-posterior, VP = Ventro-posterior. Each nucleus displays a unique colour (enabling to view some of them on multiple plans)

- The striatum is divided into three main nuclei: the putamen, the nucleus accumbens and the caudate
- These nuclei can be further divided into 10 subnuclei according to their functional connectivity to the whole brain (Tian et al., 2020).
- It is one of the major dopaminergic hubs of the brain that receives and sends projections to many cortical and subcortical areas.
- We suggest maladaptive behaviours seen in addiction rely on distributed processes that involve this region together with their interactions with other brain regions.

Relationship between striatum and addiction



Prediction of group 2 behaviours using group 1 edges



- We predicted the tobacco and impulsivity latent behaviours of group 2 from group 1 RSFC.
- We extracted 25 striatal connectivities relevant for these predictions.

Summary

Exploratory sample (n=319)

- We inferred the mean resting-state functional connectivity (RSFC) of the striatum subdivisions
- We extracted 3 latent behaviours from more than 600 participants [i) Tobacco use, ii) Alcohol abuse ; (iii) Illicit druge use] and a transdiagnostic marker of impulsivity
- We splited our exploratory group into 2 groups and predicted the 2nd one with the 1st group

Next step

Confirmatory sample (n=318)

- Training on the exploratory sample to predict the confirmatory sample (ongoing)
- Applying the exploratory weight to the confirmatory sample (unseen data)

One more thing

Scan me if you want to stay up to date with my work

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References

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