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Dear Dr. Dusseldorp, Dr. Weeda, and members of the search committee:

I am writing to express my interest in the post of Assistant Professor Methodology & Statistics (vacancy 11349) at Leiden University. I completed my doctoral training at the University of North Carolina at Chapel Hill (UNC) and am currently a postdoctoral researcher at the Donders Institute at the Radboud University Medical Center. My prior experience in **research**, **teaching and dissemination**, and **collaboration with applied researchers** make me an excellent fit for the post. My research program focuses on the development and application of novel quantitative methodology in the field of developmental and cognitive neuroscience, with two key contributions: 1) **novel univariate and network approaches** to understand neural changes during feedback learning and across development, and 2) **psychometric and longitudinal modeling** to better understand the structure of measurements in the behavioral and neural sciences and how they develop over time. In both these lines of research I have demonstrated independence of thought and the ability to use quantitative methods to solve pressing theoretical problems in applied research. I have an excellent track record of publication, and my work has been published in diverse and respected outlets, including *Developmental Cognitive Neuroscience*, *NeuroImage*, and *Network Neuroscience*. Below I outline how my prior experience and interests would complement the expertise in the Methodology and Statistics unit and interface with the broader members of the Social and Behavioural Sciences faculty.

Statistical Methods for fMRI Analysis

My research focuses on the measurement and modeling of change over time of behavioral performance and neural responses involved in learning, and how those systems in turn change over development. My early work focused on age-related changes in feedback learning (McCormick & Telzer, 2017a; 2017b; 2018a) using **task-based functional MRI** to assess neural-evoked responses to reward and punishment. To assess feedback learning, I applied longitudinal mixed-effects modeling of behavioral performance and novel specifications of univariate fMRI models during feedback learning. This research highlighted a particular role for the medial prefrontal cortex in feedback learning during adolescence and found that adolescent-specific increases in learning and sensitivity to feedback are linked to the stereotypical increases in risky behavior seen in the teen years. Because feedback learning is a distributed process, I then developed and applied expertise in **network approaches** to functional neuroimaging (McCormick, van Hoorn, Cohen, & Telzer, 2018) to understand how brain dynamics might contribute to feedback learning and risky behavior. In this work, I utilized **intensive longitudinal models** such as vector autoregression and structural equation modeling to build network models of fMRI data during risky decision-making (McCormick & Telzer, 2018b; McCormick, Gates, & Telzer, 2019). These approaches gave novel insights into dynamic processes that contribute to behavior that would be invisible to traditional univariate analyses. More recently, I extended this work in intensive longitudinal modeling to model behavioral variability and link individual differences in performance to white matter measures of brain structure in a lifespan sample using dynamic structural equation modeling (McCormick, Cam-CAN, & Kievit, *preprint*).

Longitudinal and Psychometric Models

In addition to substantive research in developmental cognitive neuroimaging, I have also developed a strong research program in longitudinal and psychometric modeling. Through my early use of longitudinal models for behavioral change during learning, I became deeply interested in how we can incorporate learning into models change over age or maturation. However, to probe these questions, I had to overcome two primary challenges. The first was the lack of access to longitudinal fMRI data on feedback learning, with most of my early work focusing on cross-sectional samples. The second and more fundamental is that in the most common kind of longitudinal study, the cohort design where a

group of same-age individuals are measured repeatedly, practice and experience are entirely confounded with age. To address these challenges, I proactively established an international collaboration with researchers at Leiden University and obtained funding to visit the Brain and Development Lab (under the direction of Prof. Eveline Crone) during my dissertation. In Leiden, I was given generous access to data from the BrainTime study, a large accelerated longitudinal study of children and adolescents (N = 299, ages 8-29). Accelerated studies combine features of cross-sectional and cohort designs, where individuals are measured repeatedly but at different initial ages. This approach allows a study to assess a much broader age range with fewer individual assessments, but more importantly, decouples age from experience with the assessment itself through the use of planned missing data. This central insight into the importance of missing data in modeling practice and age lead to my **sole-author paper on multi-growth models**, an approach to measuring simultaneous growth processes (McCormick, 2021). In this independent work, I proposed a general principle for leveraging missing data in longitudinal samples to decouple growth processes which occur across time together – and therefore tend to be highly correlated in sample data – but have different causal mechanisms. In this paper, I focused on two key scenarios of interest in substantive research: 1) **modeling retest effects (e.g., practice, habituation) and age**, and 2) **age and pubertal development**. I highlighted how existing data from open-access studies of adolescent development, like BrainTime and ABCD, could be used to model these multiple growth processes. In a subsequent publication, I demonstrated the strength of the multi-growth model to test novel developmental hypothesis in the BrainTime data (McCormick, Peters, Crone, & Telzer, 2021). Here we showed that experience appears to compensate for age-related decreases in feedback learning performance and network modularity during young adulthood compared with adolescence. Importantly, the multi-growth framework enabled us to test for effects that would be invisible to traditional longitudinal analyses. To extend this work, I have recently submitted grants to the **Dutch NWO-XS mechanism** and **Jacobs Foundation Early Career Fellowship** (advanced to second round). In addition to my work on modeling multiple growth processes, I am also working on new approaches for predicting outcomes from growth models (McCormick, Curran, & Hancock, *in prep*).

In addition to my work on longitudinal modeling, another arm of my research focuses on psychometric measurement and improving the ability to derive valid and reliable measures in statistical models. One key theoretical interest in cognitive neuroscience is understanding "intrinsic" brain dynamics. For many years, resting state fMRI data has been used to assess intrinsic functional connectivity from fluctuations when participants were not actively performing a task (i.e., "at rest"), however more recent work has cast doubt on the validity of resting state as capturing truly intrinsic functional connectivity. To explore the potential for psychometric models to build a more generalizable measure of functional connectivity, I used a **factor analytic approach to generate a latent measure of the common variance of functional connectivity** from multiple brain scans (i.e., "latent FC"), including both resting and multiple task states (McCormick, Arnemann, Ito, Hanson, & Cole, 2022). We showed that compared to resting state alone, the principled aggregation of information using latent FC had better predictive validity of held out task state activation *and* an external measure of general intelligence. This project demonstrating the exciting possibilities of using psychometric models in cognitive neuroscience. My more recent psychometric work focuses in providing **new diagnostics for mediation analyses**, one of the most common models in the behavioral sciences, especially in clinical applications. Here we are focusing on the use of scale scores and other composites as mediators and how the combination of individual measures might introduce confounds into the analysis. We have developed a structural equation modeling framework for testing for this mediation confounding and plan to launch a freely available Shiny app to perform these diagnostics (McCormick, Borgeest, Rhemtulla, & Kievit, *in prep*). This work seeks to make the principles and tools of psychometric measurement models more widely available in applied research.

My work intersects with the faculty of the Methodology and Statistics unit and broader Social and Behavioural Sciences faculty in many promising and mutually beneficial ways. Cutting across two of the unit's core interests, my program of research has many points of potential collaboration within the unit including, **Dr. Wouter Weeda** on improving methods of estimation for

functional MRI phenotypes, **Dr. Mark de Rooij** and **Dr. Zsuzsa Bakk** on prediction in longitudinal models (especially with non-normal and categorical data), and **Dr. Anna van 't Veer** on improving methods and practices in the psychological and brain sciences. Additionally, my research on longitudinal and psychometric models has grown out of the applied challenges in the context of neuroimaging and psychological research. Indeed, my prior work has already brought me into collaboration with faculty at Leiden University, including **Dr. Sabine Peters**, **Dr. Anna van Duijvenvoorde**, and **Professor Dr. Eveline Crone** in the Developmental and Educational Psychology unit. I would deepen these existing collaborative ties as well as expand them to include additional researchers interested in applying advanced modeling approaches in their own work.

Teaching and Dissemination

In addition to my strong research track-record, I am committed to the teaching and dissemination of quantitative methods to the broader communities of psychology, neuroscience, and related fields. While in graduate school, I assisted in the teaching of Introduction to Statistics for bachelor's students, and following my PhD, I was the instructor of record for this class at the University of North Carolina (35 students). In addition to developing material to teach the principles of the general linear model, I navigated the rapid transition to online-only instruction due to the COVID-19 pandemic. Despite the challenges associated with the early months of lockdowns and remote instruction, the students and I were able to successfully adapt the course to allow for student learning while accommodating the unique challenges and inequities in internet access that students were experiencing. This experience taught me invaluable lessons in the need for flexible teaching practices to meet students' diverse needs, especially in quantitative courses where they often feel less comfortable with the material.

My involvement in teaching and dissemination is extensive outside the traditional classroom as well. I have been continuously involved in a series of workshops on advanced quantitative models since the completion of my PhD through The Center for Statistical Training (CenterStat) by Curran-Bauer Analytics. These week-long workshops cover methods such as (longitudinal) structural equation modeling, multilevel modeling, measurement modeling, clustering and network analysis, and machine learning. In addition to lectures, I run software demonstration sessions in R where we provide practical knowledge about fitting these models on real data. Workshops that I have supported, including a free 3-day introduction to SEM, have collectively been attended by thousands of researchers from around the world, making these approaches much more widely available. In addition to these courses, I have participated in obtaining funding ($121,800 total costs) for a summer workshop on longitudinal modeling in developmental cognitive neuroscience (https://abcdworkshop.github.io/). As part of this workshop, I gave a day-long course on longitudinal SEM methods, which is less often used in this field compared with mixed-effects approaches. The goal of this session was to equip early career researchers with methodological tools to test their theoretical research hypotheses that they might lack at their home institutions. I will give a follow-up workshop on more advanced SEM approaches at the annual meeting of the Flux Society for developmental cognitive neuroscience this September.

As a culmination of my dissemination work thus far, I collaborated with colleagues involved in the ABCD workshop to develop a **primer on longitudinal modeling** (McCormick, Byrne, Flournoy, Mills, & Pfeifer, *preprint*). In this primer, we provide a detailed comparison of the relative strengths between mixed-effect (multilevel and generalized additive) and structural equation (latent curve and latent change score) models for modeling change over time. The goal of this primer is to provide an accessible baseline of knowledge for early career researchers interested in longitudinal modeling and a platform for further learning in these methods. In addition to the discussion provided in the primer, I am also building an online codebook companion (https://mccormickneuro.github.io/longitudinal-primer/) to the manuscript with publicly available data and code (primarily in R but with some options in Mplus and SAS) for fitting these models.

Values in Science

Woven throughout all my research and teaching activities is a strong commitment to 3 key principles: **1) diversity and inclusion in training, research, and dissemination, 2) open and**

reproducible science, and 3) collaboration and support between quantitative and applied researchers. As part of my focus on diversity and inclusion, I have taken **leadership roles in several diversity initiatives** in the field of developmental cognitive neuroscience. For instance, I help run the LGBTQIA+ Affinity Group and am a member of the Diversity Committee for the Flux Society. As a part of our 2022 annual meeting, we are organizing a Diversity Session which focuses on place-based inequities, including enhancing access for researchers in low- and middle-income countries, recognizing the limitations of right-restricting laws for minoritized groups (including women and queer individuals) on researcher mobility, and the role that the systematic exclusion of minorities from academics plays in current disparities in the retention of minority scholars in academics. As a queer scientist, I am especially interested in how we can support the inclusion of queer perspectives and investigators in both quantitative and applied research.

Secondly, I have an established record of **supporting open and reproducible science** in throughout my research. In addition to consistently making the code and data associated with my publications publicly available, I host stable PDF versions of all publications on my personal website to ensure access for everyone. I have also contributed to open-source R-based coding projects, including being a contributor to the GIMME R-package (https://gimme.web.unc.edu/) during my PhD and developing my own package and Shiny app for mediation diagnostics. Furthermore, the primer codebook companion represents a large effort to make the fitting of a broad class of longitudinal models freely available for all.

Finally, my philosophy of quantitative methods is that we occupy a key position in the development and advancement of theoretical questions. As such, my research on advanced methods is informed, in part, by the **needs and aims of colleagues in substantive areas**. This makes me an ideal candidate for establishing collaborations between the members of the Methodology and Statistics unit and the broader Social and Behavioural Sciences. This can be seen in my record of publication during graduate and post-graduate training (e.g., Van Hoorn, McCormick, & Telzer, 2018; Muscatell, McCormick, & Telzer, 2018; Do, McCormick, & Telzer, 2020; Metherell, Ghai, McCormick, Fort, & Orben, *preprint*) where I often provided statistical expertise to support research by my colleagues resulting in over ten additional publications.

Technical Qualifications

While I primarily conduct my research using freely-available programs – **primarily R and Python** – I have extensive experience in proprietary software such as Mplus for latent variable models, SAS for mixed-effect models, and SPSS for analyses within the general linear model. Consistent with my expertise and prior work, I am capable of teaching courses related to the general linear model (e.g., ANOVA, regression), mixed-effects models, structural equation modeling, especially as they relate to longitudinal or psychometric data analysis. I am committed to obtaining the University Teaching Qualification as soon as possible to facilitate teaching.

Along with this letter, I have included my curriculum vitae and contact information for Dr. Rogier Kievit and Dr. Patrick Curran to provide references for my work.

Please do not hesitate to contact me if you have any questions or need any additional information. I can be reached by phone (+310638940421) or email (ethan.mccormick@radboudumc). Thank you for your consideration, and I hope to hear from you in due course.

Sincerely,

Ethan McCormick

Ethan M. McCormick

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