Title of the study (one request per article):
Developmental eye tracking – the good, the bad and the ugly

Contact person for the proposed study: (please note that this should be level postdoc or higher)	
Name:	Roy S. Hessels
Institution:	Utrecht University
Department:	Experimental Psychology, Helmholtz Institute
Address:	Heidelberglaan 1, 3584 CS, Utrecht
Email:	r.s.hessels@uu.nl

Contact person in YOUth Data Management Committee:	
Name:	Chantal Kemner
Institution:	Utrecht University
Department:	Experimental Psychology, Helmholtz Institute
Address:	Heidelberglaan 1, 3584 CS, Utrecht
Email:	c.kemner@uu.nl

Wave (more options are possible):

- ☐ Rondom zw – 20 weeks
- ☐ Rondom zw – 30 weeks
- ☒ Rondom 0 – 5 mo
- ☒ Rondom 0 – 10 mo
- ☒ Rondom 3 (not available yet)
- ☐ Rondom 6 (not available yet)
- ☒ Rondom 9
- ☐ Rondom 12 (not available yet)
- ☐ Rondom 15 (not available yet)

We ask you to provide us with a clear background, methods section and data-analysis plan. These parts of the proposal will be publicly displayed for reference.

Background of the project (max. 500 words): Please provide a short background including the rational of your study as you would do in an introduction of the paper

One of the main research methods for gaining insights into cognitive development is eye tracking, through which gaze direction is objectively measured. The main benefit of this technique is that it provides a glimpse of the world through the eyes of a developing child (the good). In the YOUth cohorts, eye-tracking is therefore one of the main neurocognitive domains. However, eye tracking in the context of development is also challenging. Eye-tracking data quality is often low compared with adult research, and dependent on many human and technical factors. This may cause invalid conclusions to be drawn about child development, particularly at the individual level (the bad).

The question addressed in this paper is twofold. First, we address how we have used our knowledge on eye-tracking data quality to improve eye-tracking measurements in the YOUth cohorts. We show how state-of-the-art techniques have been used to optimize the geometry of the measurement, which includes the participant, the eye tracker, and the laboratory and the data-collection protocol, which includes the training of the research assistants, the calibration and data-monitoring procedures. We will use data examples from the YOUth cohorts to show how eye-tracking data quality varies between research assistants and address what that may mean for data analysis.

Second, we adress how we can use our knowledge of eye-tracking data quality to improve our data analysis in the YOUth cohorts. We report distributions of data quality metrics for all available age ranges. We then discuss how data of low and high quality (which may differ between age ranges and individuals) can be successfully analyzed such that valid conclusions about child development may be drawn.

In this paper, we tackle the ugly problems that are not always the primary interest of developmental psychologists, yet are imperative to ensure that valid developmental conclusions can be drawn. We end with advice for longitudinal eye-tracking studies and generalizations to other neurocognitive domains (e.g. EEG).

Research question

1) How have we used our knowledge on eye-tracking data quality to improve eye-tracking measurements in the YOUth cohorts?

2) How can we use our knowledge on eye-tracking data quality to improve eye-tracking data analysis in the YOUth cohorts?

Methods Describe the methods as in the paper in which the data will be presented, according to the categories below, with a total **maximum** of 1500 words. For a description of task, methods etc. refer to the website, if possible.

Design of the study (for instance cross-sectional, longitudinal etc.; substantiate your choices)

Eye-tracking data quality metrics will be reported in a cross-sectional fashion for 5 months, 10 months, 3 years and 9 years age ranges. The goal is to describe normative ranges of data quality metrics in order to give advice on how eye-tracking data from the YOUth cohort studies can be analyzed. We use data from one experiment: the gap-overlap task, to calculate eye-tracking data quality measures. The reason for this task is that it is most often recorded as the second experiment. Given that data quality generally decreases with time since start of the measurement, the middle experiment will give a more reasonable estimate of the quality of the YOUth cohort eye-tracking data than the first or last experiments. Moreover, the gap-overlap task is used in both the infant and child cohorts.

Study population and sample-size (entire population or a subset; substantiate your choices e.g. Provide a rationale for the requested sample-size, for instance using a power calculation)
500 random sets are requested from each time point, or the maximum number of available sets in case this number is not yet exceeded (3 years age range). The number of sets (500) is based on the assumption that 500 sets allows us to compute adequate normative ranges of data quality measures (the largest sample size currently available in the literature) and the assumption that any more sets will not yield additional insights.
Data processing and preparation (including necessary recoding of data etc.)
Two major data quality metrics will be reported: Root Mean Square sample-to-sample deviation as a measure for the variable error in eye-tracking data, and proportion missing samples as a measure of data loss. Measures are calculated for each eye separately, and compared with each other so that advice on how to deal with averaging data from the two eyes can be given, or advice on when to take data from one eye.
Handling missing data (describe how you will detect and handle missingness in the data)
Missing data is an important metric in this study, it is part of the aims to describe how much missing can occur. The only kind of missing data that cannot be detected is when no eye-tracking measurement was conducted for a participant in the YOUth cohort. Given that the emphasis is on eye-tracking data quality metrics, this is not problematic.
Data analysis methods (including statistical design and statistical analysis plan. If it is not possible to provide a detailed statistical plan, as this does not fit in with the research questions formulated above, please explain.)
See data processing. The paper gives a description of data quality metrics, there are no hypotheses to be tested, and statistical hypotheses-testing therefore does not play a role.
Planned subgroup analyses (if applicable. Substantiate your choices)
Data quality metrics are calculated separately for the top 5 research assistants who have done the most measurements in the 5/10 month-old age ranges. Ranges of data quality metrics are then compared between these research assistants (anonymously) in order to show the effect of different operators on data quality.
Planned sensitivity analyses (if applicable. Substantiate your choices) Sensitivity analyses are analyses that you plan beforehand to test whether certain factors have a major influence on your results.
Not applicable.

2. Timeline and milestones (including dates of when to analyze/write up):
Introduction is written, data analysis is planned for february - april. Submission around the summer 2019.

3. Output (e.g. article, report, etc.):
Paper submitted to special issue in Developmental Cognitive Neuroscience on the Consortium Individual Development.

4. Proposed authors + affiliations (please note that the YOUth data access committee can request certain authors to be included):

Roy S. Hessels
Experimental Psychology, Helmholtz Institute, Utrecht University, Utrecht, the Netherlands &
Developmental Psychology, Utrecht University, Utrecht, the Netherlands

Chantal Kemner
Experimental Psychology, Helmholtz Institute, Utrecht University, Utrecht, the Netherlands &
Developmental Psychology, Utrecht University, Utrecht, the Netherlands & Brain Center Rudolf Magnus, University Medical Center, Utrecht, The Netherlands

Ignace T. C. Hooge
Experimental Psychology, Helmholtz Institute, Utrecht University, Utrecht, the Netherlands

This form should be sent to: Secretary of Chantal Kemner: i.bleeker@uu.nl