# Survey of Automated Methods for Nonverbal Behavior Analysis in Parent-Child Interactions

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## 1 Introduction

Parent-child interactions (PCIs) provide valuable insights into various aspects of a child's development such as cognition, language acquisition, social-emotional growth, as well as the achievement of developmental milestones [8]. Observations of PCIs have therefore been commonly employed to assess and monitor the development of the child [1, 8]. Traditionally, trained experts manually code these interactions [2, 7] which is time-consuming and necessitates extensive training [8]. However, recent advancements in automated behavior analysis promise a paradigm shift, providing a cost-effective alternative and enabling a more objective analysis of large amounts of data. This literature survey, based on [6], aims to bridge the disciplines of developmental psychology and computer sciences, emphasizing the potential for automating behavioral coding to interpret developmental constructs. Additionally, it addresses the unique challenges in analyzing child behavior, as well as understanding the complexity of PCIs.

## 2 Contribution

Developmental constructs play a significant role in interpreting the interactive behavior and understanding the development of the child [3–5]. The social sciences have developed and validated a variety of instruments to measure these constructs. However, these high-level constructs are too complex to measure directly, and require the interpretations of experts. Since, the developed models to automate the behavior analysis lack the ability to interpret the observations, in computer analysis studies researchers mainly focused on measurable features associated with these constructs. In this manner, computer science methods aim to provide quantitative measurements for high-level constructs [10].

Given the existence of well-developed models, and the fact that young children primarily rely on nonverbal behaviors to communicate, a remarkable part of the studies focus on single-person features, such as facial expressions, body movements, nonverbal vocalizations, as well as the combination of these modalities. However, to fully understand and interpret the interactions, there is a need for consideration of both interactants [9]. Following this, some studies focused

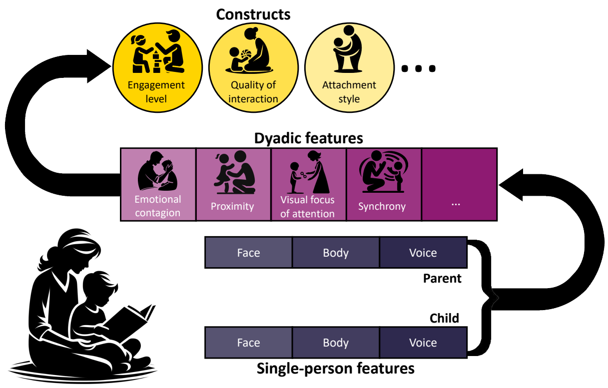


**Fig. 1.** Schematic overview of the process of measuring and interpreting interactive behavior in parent-child interactions. Recordings are first analyzed for single-person behaviors, before combining these into dyadic features. Finally, interpretation takes place in terms of constructs for the child's development or the interaction quality.

on interaction-level dyadic features, identifying specific inter-personal measures, such as emotional contagion, proximity, touch, visual focus of attention, and synchrony. This approach has led to more robust behavior coding and a deeper understanding of PCIs.

In line with this, by reviewing the studies had been done in the field of automated behavior analysis in parent-child interactions, we defined different levels of analysis for interactions. Briefly, automatic behavior analysis in PCIs can be discussed in three different levels: focusing on individual level single-person features, examining interaction-level dyadic features, and finally analyzing more complex developmental constructs such as engagement level, quality of interaction, and attachment style. An overview of the process appears in Figure 1.

## 3 Key Findings

Automated methods provide a more objective and cost-effective alternative to manual coding. We observe a trend towards fully automating the qualitative or quantitative assessment of higher-order constructs in terms of the interaction quality or development of the child. Despite considerable advancements in the robustness of measurement tools, there remains relatively limited focus on the behavior analysis of children. We have outlined some challenges such as the exclusion of behavioral functions and a lack of attention to temporal dynamics, overlooking the behavior patterns across different modalities. Furthermore, there is a potential for improvement regarding the assessment of temporal dyadic behaviors such as leader-follower dynamics. By adopting a more multimodal approach, we can increasingly shift from form to function. This shift will advance the interpretability of the measurements, and will bridge the gap between automated objective coding, and the more subjective assessment of complex constructs.

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