

Using Visual Analytics to Understand Social and Communicative Behaviors

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ABSTRACT

Technologies are providing new opportunities for psychologists to record and study human behaviors in unprecedented detail. In time, such rich behavioral datasets will be collected by psychologists everywhere. We are studying the use of technologies to capture, measure, analyze and understand human social and communicative behaviors. However, the massive amount of video/audio/sensing data collected during multimodal interactions from hundreds of subjects can be difficult to explore for psychology researchers. We investigate how visual analytics can be of help in providing a new method for exploring such challenging datasets.

Index Terms: H.5.2 [Information Interface and Presentation]: User Interfaces—User-centered design

1 INTRODUCTION

Psychology researchers have long studied early developmental trajectories of social and communicative behaviors in children, and used this information to understand early signs of developmental disorders such as autism. The earlier delays can be identified, the earlier they can be treated. Plenty of evidence suggests that early intervention leads to optimal outcomes. With the advances in automated capture technologies, nowadays psychologists can use high-definition synchronized cameras, microphones and wearable sensors to record and analyze human behaviors in unprecedented detail [1]. However, the new technologies bring new opportunities as well as interdisciplinary challenges in data capture, processing and analysis that require the collaboration of computer scientists and psychologists. We are studying the use of these technologies for better understanding human behavior.

Our initial focus is on understanding the development of social and communicative behaviors of children. We captured behaviors using a short 5-minute semi-structured play protocol at a table between an examiner and a child [1]. The protocol, called Rapid-ABC (RABC), is designed to elicit key social and communication behaviors in the first two years of life. It includes five interactive stages: 1) greeting the child, 2) rolling a ball back and forth with the child, 3) reading a book with the child, 4) being silly by putting a book on the examiner’s head and 5) tickling the child. The examiner’s behavior during each stage is structured in that the examiner makes a number of specific social bids to the child using speech and gestures. For example, during the book stage, the examiner might say “Let’s see what’s next” to see if the child will turn a page in the book, and during the tickle stage she might pause and wiggle her fingers to see if the child will make eye contact. One way to analyze this interaction, therefore, is to break it down into a series of

examiner bids (EB), each one starting with the initiation of the examiner’s bid and ending with the child’s reaction or response. As part of the scoring protocol for this assessment, the examiner notes, for each stage, whether the child exhibited key behaviors of interest such as looks and smiles to the examiner, and rates the child’s level of engagement in the interaction on a 3-point Likert scale from easy to difficult to engage.

To automatically capture the behaviors in RABC, we instrumented a data collection lab in a university [1]. The lab contains 13 video cameras, a Microsoft Kinect sensor and two microphones to capture everything happening in the area. Additionally, during each session, both the child and the examiner wear a lapel microphone, as well as Affectiva Q sensors on both wrists that measure electrodermal activity, accelerometry, and temperature.

To date, we have recorded the RABC protocol with over 140 children between the ages of 15 and 30 months, as part of an ongoing research study. A subset of these children also participated in a second session, one to three months after their initial session. In addition to the play protocol, data collected during each visit includes a family demographic form and two developmental questionnaires that the caregivers fill out about their child’s social, communication, and play skills.

Our work analyzes this multimodal behavior dataset with the explicit goal of exploring how visual analytics may support psychological research on child development. Current practices around visualization in psychology focus on graphs that visualize results from statistical analysis. We believe there is much opportunity to introduce visual analytics to this research community as a new methodology to support data exploration and hypothesis generation for such rich behavior datasets. To our knowledge, visual analytics has been widely applied in physiological health but not psychological health, especially for behavior analysis [3].

2 USER TASKS

Our users are developmental psychology researchers who wish to extensively explore the data for insights and generating hypotheses about human behavior. We informally consulted three developmental psychologists from three different institutions to understand how visualization may support behavior analysis tasks. The following list of exploratory tasks are promising:

1. Identify subgroups of children that exhibit similar behavior patterns
2. Examine how social behaviors differ among children
3. Discover subtle, non-obvious behavioral patterns
4. Understand co-occurrence of behaviors
5. Pinpoint quality issues in the collected data

3 DESIGN CONCEPT

We use the well-known infovis design premise: “Overview First, Zoom and Filter, Details on Demand [2]” for the project. At the higher level, we focus on four key modes of communication that are most commonly used by children of this age: gaze, voice, gesture and affect. In Figure 1, these modes are represented by the four bright colors and can be further divided into subcategories for further exploration. For example, the category gaze can be further

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divided into specific gaze targets (gaze at examiner, gaze at parent etc.) and the category gesture can be further divided into specific types of gesture (pointing, pat on table etc.).

There are four main views in this visual analytics system as shown in Figure 1. The views show different perspectives on the data and are connected through linking and brushing. The psychology researchers are expected to go back and forth between the views to explore how the detailed views connect to the aggregated perspectives. Note that in this concept design, the visualizations utilize made-up data.

3.1 Multiples View - Figure 1 (1)

This high-level overview shows the most common behaviors across the RABC session for the four key modes of communication. On the horizontal axis is the list of EBs, arranged roughly in the order of appearance in the RABC session. The height of the bar is the number of children that have a certain percentage of behavioral events within that EB. For example, in Figure 1 (1), the first two bars in the gaze bar chart show that there far fewer subjects showing over 50% (K) of meaningful gaze events in the first EB (G1) than in the second one (G2). The researcher can dynamically tune the behavior percentage threshold (K) through the slider on the left side of the bar charts. The shorter bars with brighter colors show subjects that are selected in other views.

3.2 Distribution View - Figure 1 (2)

This view provides more details in one or more EBs by distributing the subjects based on the occurrence percentage of behaviors within those EBs. In Figure 1 (2), three EBs (Bo2, Bo3, Bo4) are selected (highlighted bars above the chart title). The four modes of communication are now on the horizontal axis. The length of the bar shows how many subjects have that percentage of behaviors within the selected EBs. Subjects in the view can be selected for further investigation in other views. For example, 14 subjects are selected in Figure 1 (2). They each have approximately 50% of voice-based events within the three selected EBs.

3.3 Data Investigation Panels - Figure 1 (3)

This region is for flexibly displaying the details of other views. It consists of multiple panels that can be selectively configured by the researcher. Depending on the investigation goals, a variety of visualizations are available based on the data source being selected in other views. For example, in the top panel in Figure 1 (3), a line chart is used to compare the confidence levels of gaze and smile events over time for the second subject selected. Similarly, videos could also be played back as shown in the third panel.

3.4 Temporal Heat Bars - Figure 1 (4)

This view shows the behaviors on a linear timeline for a better view of the temporal relationships between them. The colored bars are the four modes of communication. The horizontal axis is time. The darker shade on the colored bar shows that more subjects are exhibiting the specified mode of communication in that time period. The vertical bars with labels align the start of each EB of the selected subjects. The researcher can click on the arrows at the bottom of the vertical bars to expand the space of each EB to see more details. The period between two consecutive EBs is the longest EB among the selected subjects. For more detailed per subject information, the researcher can click on the colored bars to use a lens-like interface to explore the behaviors of the selected subjects separately as shown on the first colored bar in Figure 1 (4).

4 DISCUSSION AND FUTURE WORK

Psychologists do not typically use visualizations for data exploration and hypotheses generation. From our early discussions with developmental psychologists, it is unclear how much value visual

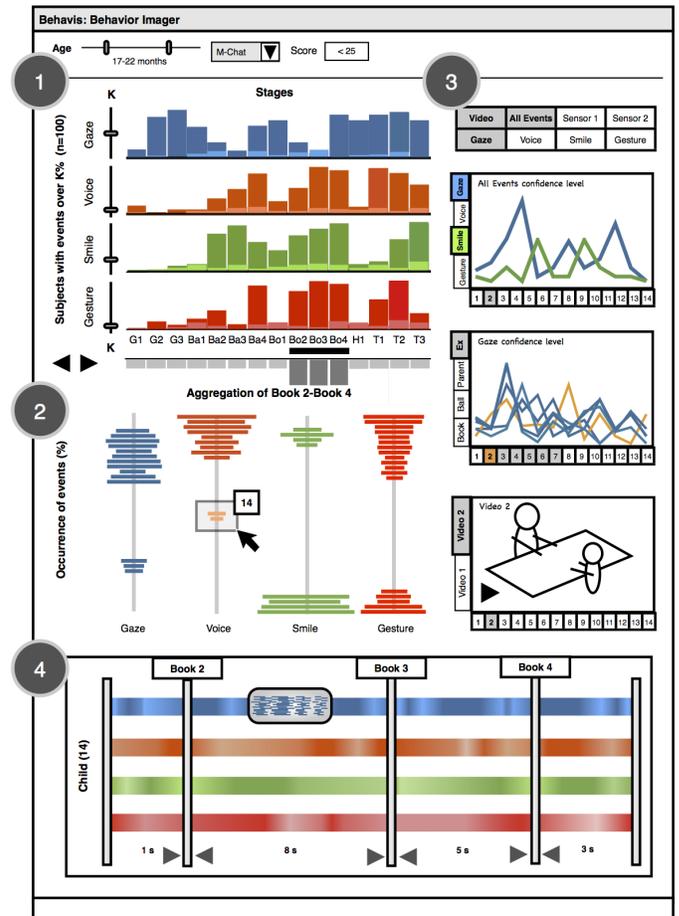


Figure 1: Design Concept. (1) Multiples View (2) Distribution View (3) Data Investigation Panels (4) Temporal Heat Bars

analytics can bring without letting them try the visualizations out with real data. As a result, we need to bring working prototypes to the psychologists to collaboratively understand how visual analytics could be useful in supporting psychology research.

There is a large amount of variability in human behaviors. Not only do the children take a variable amount of time to finish each EB, some behave in ways where our human annotators have a hard time coding the behaviors. As a result, to aggregate the data among multiple children, we need to normalize or realign the behaviors in each EB which renders the interpretation more challenging.

With more automated capture technologies being affordably available, psychologists will inevitably be increasingly relying on them to study human behavior. Visual analytics may provide a new approach to data analysis, but the challenge remains as to how to design visualizations that can support different exploration tasks. Therefore, we believe that, similar to medical data visualizations, there is much to be explored and studied in this application domain.

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