Using a Fitness Tracker to Predict Automatically Reinforced Problem Behavior

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Introduction

- Smart watches have become ubiquitous in developed nations due to their falling cost and increased functionality
- Among their many uses, smart watches can serve as fitness trackers that monitor body temperature, heart rate (HR), muscle motion, and other health data (Lu et al., 2016)
- Automatically reinforced problem behaviors associated with heightened states of physical activity (e.g., self-injurious behavior) may correlate with increased HR
- Similarly, elevated HR could be predictive of problem behavior before it occurs
- If a relationship were established between elevated HR and problem behavior, then HR could potentially be used a cue to take action before the behavior begins

Method

Participants

- A fifteen year old male with autism who has a history of automatically reinforced problem behavior
- A Functional Behavior Assessment was conducted on the subject to rule out socially mediated reinforcement of problem behavior

Targets

- *Partial Overlap:* The percentage of problem behaviors where the reported time of the problem behavior partially overlapped with an elevated heart rate (HR $>$ 100 bpm)
- *Precedes Onset:* The percentage of problem behaviors where the reported time of the problem behavior was preceded by an elevated heart rate (HR $>$ 100 bpm) by no more than 10 minutes
- 10 minutes was chosen to allow the increase in HR to potentially be connected to the problem behavior because not enough time would have elapsed for a cool-down period to occur
- Problem behavior was defined as self-injurious behavior (i.e., hand biting, striking the face with a closed fist, and head banging) and/or aggression towards others (i.e., attempts to bite, hit, or kick)

Procedures

- An online form was created to collect information about each incidence of the subject's problem behavior from parents, teachers, and other caregivers
- HR information (i.e., bpm vs time) was collected from the Fitbit and downloaded into a spreadsheet
- The time and duration of each problem behavior was plotted to overlay time series data of the subject's HR to look for correlations between the two
- Information regarding the administration of emergency medication during problem behaviors was also recorded

Results

- Data was collected for a ten week period from March 15 to May 24, 2018
- Below are examples of daily data collection showing heart rate versus time of day in blue
- Incidents of problem behavior are shown as red horizontal lines with the length corresponding to the duration of the episode
- These incidents are also annotated with text giving the onset time of the problem behavior followed by its duration
- A green star annotation was also used when the subject's emergency medication was administered

Example 1: Partial Overlap

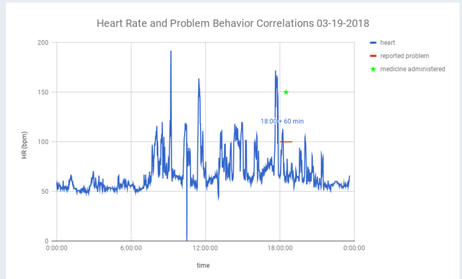

Figure: Data collected on 3/19/2018 shows partial overlap of elevated HR and the reported time of the problem behavior. This was scored as a '1' for Partial Overlap and '0' for Precedes Onset.

Example 2: HR Elevation Precedes Onset

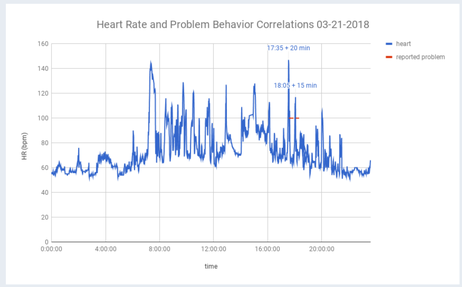

Figure: Data collected on 3/21/2018 shows two incidents with elevated HR preceding the reported onset of the problem behavior. Both were scored as a '1' for Partial Overlap and '1' for Precedes Onset.

Example 3: HR Data Unavailable

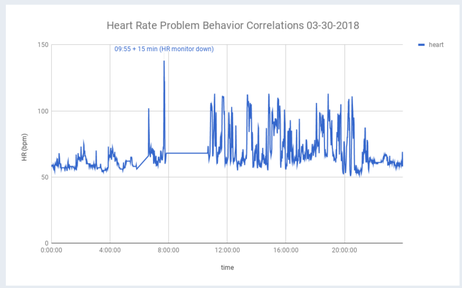

Figure: Data collected on 3/30/2018 shows a problem behavior that occurred while the Fitbit charge was low and not collecting HR information. This data point was excluded from analysis.

Example 4: No Overlap

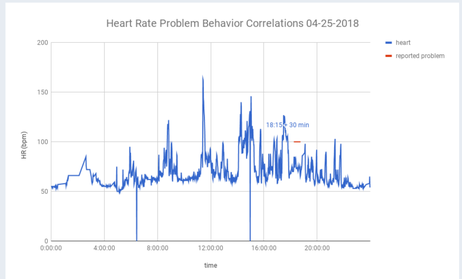

Figure: Data collected on 4/25/2018 demonstrates a problem behavior that is not preceded by an elevated HR nor does it overlap with an elevated HR. This was scored as a '0' for Partial Overlap and '0' for Precedes Onset.

Example 5: HR Elevation Follows Onset

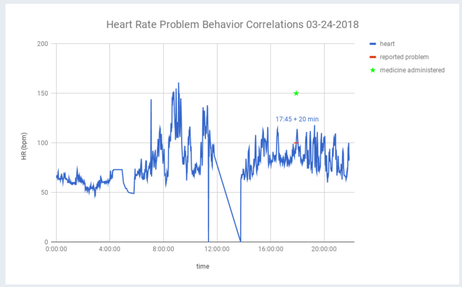

Figure: Data collected on 3/24/2018 shows an elevated HR following the reported onset of problem behavior. This was scored as a '1' for Partial Overlap and '0' for Precedes Onset.

Example 6: Multiple Problem Behaviors

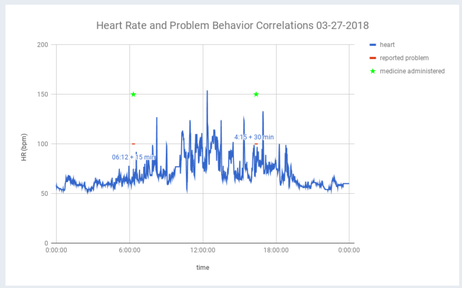

Figure: Data collected on 3/27/2018 demonstrates multiple problem behaviors on one day. Each was scored separately.

Results (continued)

Date	Partial Overlap	Precedes Onset
3/19/2018	1	0
3/21/2018	1	1
3/21/2018	1	1
3/23/2018	0	1
3/24/2018	1	0
3/27/2018	0	0
3/27/2018	0	0
3/28/2018	1	1
...	...	...
4/23/2018	1	0
4/23/2018	1	1
4/23/2018	1	1
4/24/2018	1	1
4/25/2018	0	0
5/7/2018	0	0
5/10/2018	0	1
Totals	21/32=65.6%	15/32=46.9%

- The reported time period of a problem behavior overlapped with a HR greater than 100 bpm on 65.6% of episodes
- A HR greater than 100 bpm preceded the reported onset of problem behavior on 46.9% of episodes

Discussion

- A strong relationship was not established between elevated HR and reported times of problem behavior
- The study suffered from problems with the Fitbit battery being low during problem behaviors
- There were also problems with the reliability of the reported onset/offset times (i.e., not reporting an accurate onset time due to dealing with the problem behavior itself)
- Allowing for a certain degree of error in reporting the onset time may also improve the relationship
- The HR criteria of 100 bpm is somewhat arbitrary and adjusting this value may yield better results
- Future studies could determine if a self-monitoring intervention could help caregivers implement antecedent strategies to deter potential problem behaviors before they arise

References

Lu, T. et al. (2016), Healthcare Applications of Smart Watches. *Applied Clinical Informatics, 7*(3), 850-869

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- ptsouth97@gmail.com
- https://github.com/ptsouth97/FitnessTracker