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UPRITE: Promoting Positive Posture in Children and Adolescents

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Abstract. Technology use associated with habitual posture is linked with the decline in mental well-being. The objective of this study was to evaluate the potential of posture improvement through game play. 73 children and adolescents were recruited, and accelerometer data collected through game play was analyzed. The data analysis reveals that the game/app affects and encourages upright/vertical posture.

Keywords. accelerometers, smart phone, tablet device, posture analysis, tech neck, children, adolescents, game app, sagittal neck posture, mental health

1. Introduction

Neck pain (tech neck) and postural issues as well as mental health issues [1] are associated with lifestyle factors such as increased screen and computer use, and increased time spent sitting [2-4]. In Australia, children aged 4 – 13 years spent an average of 2.2 hours on screen time activities, doubling from 1.6 hours at 4 – 5 years, to 3.3 hours at 12 – 13 years [5]. Acknowledging these and the crucial part of mobile technology in their lives it is important to find ways to embed in the technology means to help with positive posture which will equip this age group with long term benefits and maintain well-being.

One such support effort is the Ocean Explorer (a.k.a. Discovery Diver – version 2.1) digital game application. Presently, there are no known or validated digital games on the market that are primarily therapeutic and rehabilitative specifically targeting children's postural health and well-being. The Ocean Explorer is a mobile digital game which takes advantage of children's interests in smart devices to promote positive posture. Players explore the in-game ocean environments in a submersible vehicle. The game can be classified as an educational adventure game emphasizing the concepts of scientific exploration, environmental conversation, and marine biology.

Given the association of poor posture in children and their physical and psychological development, interventions to modify one's posture can improve both physical and psychological health problems. This study examined the feasibility of using technology through game play with digital natives as an intervention to improve their posture. The game utilizes accelerometry across three planes of motion to promote

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positive posture during gameplay. This paper outlines the methodology adopted to analyze the device accelerometer data gathered by the game/app while it was being played as an objective measure to infer that the device is held vertical by the participants in a controlled clinical setting. The findings of the accelerometry data is one aspect of a larger feasibility study to investigate the overall potential of inbuilt game mechanics to encourage positive posture.

2. Method

2.1. Participants

To recruit children, pediatric and adolescent allied health clinics were contacted. Parents of 87 children expressed interest. Of these children, 75 were scheduled for gameplay data collection. A total of 73 parents completed the pre-study questionnaire and 60 children completed all measurements. Mean age of children (n=73) was 12 ± 3.7 years. Majority of children (63%) were male. Informed consent was obtained from the children and their parents. This study was approved by the Flinders University Human Research Ethics Committee (Project ID: 4207).

2.2. Study setting – game play

Parents were advised to bring a mobile device that their child typically plays at home, prepared with their child's favorite game. When playing Ocean Explorer, children were provided an iPad Mini (5th Generation) with the game pre-loaded. Gameplay was recorded using Kinovea, with a lateral view of the seated subject's sagittal plane. The accelerometer data (n=73) were extracted by the developers and provided to the researchers for analysis.

2.3. Data analysis

There are numerous examples of accelerometer data being used to determine the efficacy of mobile applications or similar/related technologies designed to assess or influence the physical activity, posture, or movements of their users [6-10]. Accelerometer data is captured through an inbuilt function within the Ocean Explorer game during each child's play session. During these sessions, the device was held on its side in the landscape position. The real-world movement correlations with the three axial planes (x, y, and z) measured by the in-built iPad accelerometer were established. The x-axis represents pitch, which in the context of posture represents flexing forward or backward. The y-axis is the yaw of the tablet, or the rotation of the body left or right. The z-axis shows the roll of the device, or the lateral flexion of the participant left or right. This orientation was determined by the game development company independent to the researchers and is in-line with the established understanding of mobile device accelerometer axis positioning [7]. Sequences of accelerometer values logged for each participant were of different lengths and was therefore clustered to support improved analyses and the creation of more meaningful visualizations. Four clusters were defined for each axis. Taking inspiration from the work of Khan et al. [7] and Rowlands et al.[9], it was decided that the data would be analyzed by axis and through with the use of 95th, 90th, 75th, 50th, 25th, 10th, and 5th percentiles. The results were visualized in box and whisker plots, in a comparable fashion to the work of Rowlands et al. [9]. Khan et al. [7] established a precedent for using amplitude graphs to represent tri-axis values.

3. Results

The three axes of accelerometer data each allude to shifts in the posture and the cluster percentile value boxplots reflect these shifts through their measured trends. The x-axis, which directly correlates with vertical posture (pitch), shows a positive trend in its values, increasing from approximately -10 to 0 (y = 0.0082x – 9.6569, R2 = 0.1003). The y-axis, which represents the rotation of posture (yaw), also trended positively from a value of approximately 6 to 16 (y = 0.0083x + 6.4784, R2 = 0.911). The z-axis, correlating with lateral flexion, exhibited a very slight negative trend from about 0 to -2 (y = -0.0008x – 0.0538, R2 = 0.0186) suggesting minimal change. The predominant observable characteristic is that the variance of the data is very low, suggesting a stable vertical/upright posture. Variance escalates at the end of the graph. Variance between the clusters of the x-axis and y-axis data remains consistent. Trends do not significantly differ between clusters. Towards the end of each cluster's sequence, a period of greater variance can be observed – this correlates with the process of the exiting the game where participants are no longer fully engaged with it. All four clusters exhibit similar average values overall, aside from some outliers and more varied periods.

To better emphasize the differences between the positive- and negative-value movements across the three axes' datasets/clusters, they have been presented for comparison in amplitude graphs. The values used are an amalgamation of all the data logs in the sequences included in the datasets/clusters, rather than averages.

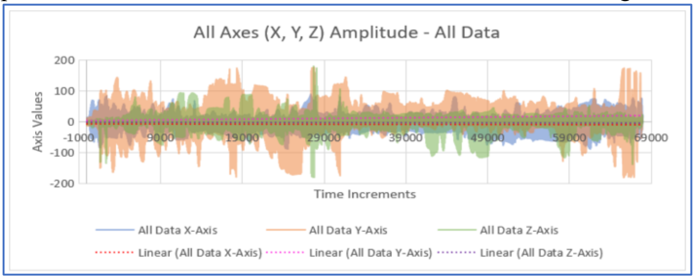

Figure 1. All Axes (X, Y, Z) Amplitude - All Data

The boxplots convey the data ranges for the percentiles calculated for each axis dataset. The highest and lowest values in the boxplot for the x-axis, y-axis and z-axis are 90 and -90, 175 to -180 and 175 to -180 respectively. The 50th percentile (median) value is approximately -7.25, 10.84 and 0.06 for x-axis, y-axis, and z-axis respectively. The other percentiles are distributed evenly around these values.

4. Discussion and Conclusions

The accelerometer data suggests that, while children are engaged with the Ocean Explorer app, the device stabilizes, indicating that it can encourage a certain device position for a period of time, thereby having some effect on the users' postural position [6-10]. The x-axis' data points were limited to a smaller range than the other two axes because of imposed restriction on players by which keeping the device in a vertical orientation is required to succeed in the game's objectives. The period of greater variance at the end of the axes', strengthens the argument for clustering since each cluster can more closely represent the parts of the sequences [9] where are active game engagement. For some clusters, there is also greater variance in the amplitude of the data sequence at the start [7], and video observation confirms that some individuals required some time to start the game in earnest and become situated. **Limitations:** The current study was not designed to measure association of stable vertical/upright device orientation with sustained upright posture and its effect on physical and psychological well-being. **Future work:** To our knowledge, this is the first study to demonstrate an innovative way of using accelerometer data and gamification to show that the orientation of the iPad correlates directly with a stable vertical/upright posture. The inbuilt iPad accelerometer has the potential to develop game mechanic imposing the device to be held vertically either as an integrated gameplay feature or as a general restriction which prevents engagement with an application without the correct orientation. Device use is associated with poor posture in adolescents [3-4], but the complex interactions between various health factors require further research [3]. The Ocean Explorer could be used in future studies as a therapeutic and rehabilitative game to explore the association of good posture and mental well-being in children and adolescent.

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