TOWSON UNIVERSITY

OFFICE OF GRADUATE STUDIES

THE RELATIONSHIP BETWEEN TECHNOLOGY USE AND NONVERBAL SENSITIVITY AT DIFFERENT AGES

by

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A thesis

Presented to the faculty of

Towson University

in partial fulfillment

of the requirements for the degree

Masters of Arts

Department of Psychology

Towson University

Towson, Maryland 21252

May, 2018

TOWSON UNIVERSITY

OFFICE OF GRADUATE STUDIES

THESIS APPROVAL PAGE

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Entitled:

The Impact of Technology Use at Different Ages on Nonverbal Sensitivity

Has been approved by the thesis committee as satisfactory completing the thesis requirements for the degree: Masters of Art (i.e., Doctor of Science)

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Abstract

The Relationship between Technology Use and Nonverbal Sensitivity at Different Ages

Belinda Chen

The use of electronic technology has increased over past several generations as technology has both improved and become more widely available. Exposure to technology during childhood may impact interaction-based learning and limit the child's opportunity to develop nonverbal communication skills. In this study, 152 participants were asked to recall their technology use at previous age points as well as their current technology use. Participants also completed a measure of nonverbal sensitivity. Elementary school age technology use and current social media use were significant mediators in that younger participants used more technology in childhood and social media which, in turn, negatively predicted nonverbal sensitivity. These findings suggest that technology use in childhood and social media use may have an unfavorable effect on one's nonverbal sensitivity.

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The Relationship between Technology Use and Nonverbal Sensitivity at Different Ages

With the advent of the modern smartphone, the percentage of American adults who own a mobile phone has grown from 65% in 2004 to 92% in 2015 (Anderson, 2015). The general population is becoming increasingly saturated with electronic technology and the amount of time spent using this technology has increased across the board as well, with children spending six or more hours a day using technology (Wakefield, 2015). If children are spending increasingly more time looking at a screen, it could be taking away opportunities for face-to-face interactions with others. It is possible that this increased technology use may inhibit the development of one's nonverbal sensitivity (i.e. communication ability), a person's ability to perceive and interpret nonverbal cues, such as body language and facial expressions. This develops throughout childhood through face-to-face interactions with other people (Keating, 2016). With the prevalence rate of late language emergence being between 10-20% among two year olds ("Late Language Emergence," n.d.), it is important to research any variables that may influence communication development in children.

Children born between 1981 and 1996, also referred to as the Millennial generation, had exposure to technology relatively early in childhood when compared to older generations, such as Baby Boomers (those born between 1946 and 1964) and Generation X (those born between 1965 and 1980). The difference in the prevalence of technology use between these generations may have an impact on the development of one's nonverbal communication abilities. Those in the youngest age group may have spent more time using electronic technology during childhood and may not have as many opportunities to have face-to-face interactions with others compared to Baby Boomers and Generation X. To explore the impact of technology use on the development of nonverbal sensitivity, the developmental arc of nonverbal communication and the change in technology use over time must first be examined.

Nonverbal Communication and its Developmental Arc

Nonverbal communication is defined as communication that is not delivered verbally as well as behaviors that must be encoded in such a way that they have meaning (Knapp, Hall, & Horgan, 2013). Nonverbal communication includes facial expressions (e.g., a smile to express happiness), body language (e.g., crossed arms to express anger), and paralanguage (e.g., intonation and hesitations when speaking to express meaning in a non-lexical manner). Nonverbal communication is used more readily to communicate social and affective-based constructs and cannot be self-regulated as well as verbal communication (DePaulo, 1992). By being able to accurately interpret another's nonverbal cues, it allows for one to interpret interactions with others more richly.

In a meta-analysis of research on the acquisition of nonverbal communication abilities, Keating (2016) tracked the general developmental arc of nonverbal communication in children. Some aspects of nonverbal communication are "biologically prepared" in a child and are not learned through interaction with others. This would include the ability to create and recognize facial expressions. For example, people who have been blind since birth make the same facial expressions as those who were born with sight (Cole, Jenkins, & Shott, 1989), which suggests that the ability to express emotions through facial expressions is innate. Within the framework of the proposed study, the focus of this review will be isolated to interaction-based acquisitions, such as pointing behaviors to direct attention (Behne, Carpenter, & Tomasello, 2005).

Interaction-based acquisitions of nonverbal communication are developed through observing and learning behaviors by interacting with others. This is because it is theorized that the time spent using technology in childhood takes opportunities away from interactions that would be the basis for interaction-based acquisitions of nonverbal communication.

Within the developmental arc of nonverbal communication, there is a concept called the developmental niche which encapsulates the physical and social settings, culture of child-rearing, and the individual characteristics of the baby and how they shape the expressive capacities and performance of a child (Harkness & Super, 1994). For example, German mothers frequently interact face-to-face with their infants and at 12 weeks of age, these infants smile and imitate their mother’s actions more frequently than infants raised in other cultures (Wörmann, Holodynski, Kärtner, & Keller, 2012). This shows the influence of face-to-face interaction on the acquisition of nonverbal abilities on infants. Nonverbal communication development can be isolated down to skills learned through touch, olfaction, and vision via interactions with their caregivers so infants learn to use these nonverbal cues for their own purposes (Keating, 2016). The Affective Social Competence model posits that individuals develop skills in three broad domains: sending (communicating one’s own affect), receiving (successful interpretation and response to others’ affective communications), and experiencing (awareness of one’s own affect) (Halberstadt, Denham, & Dunsmore, 2001). Within each of these domains, individuals develop skills throughout their lifespan through experience.

Nonverbal communication through touch and vision.

At any age, touch calls forth neural responses that suppress pain signals or activate hormonal reinforcements that modulate cortisol levels and stress (Field, 2007). For infants, tickling could be seen as forming a special bond between baby and the tickler (Provine, 2004). While the infant is still preverbal, they learn to use tactile signals to communicate immediate wants and needs to another, such as pushing away to indicate "no" (Ingram, 2014). As early as one year of age, observant infants are able to perceive the emotional tone of adults by monitoring messages from the adult's touch (Gräfenhain, Behne, Carpenter, & Tomasello, 2009). For example, a sudden and strong touch from an adult may indicate danger to a child. Through vision, emotional expressions, facial signals and gestures, and gaze are used to communicate. In the first few months of life, infants will often stare too long into others' eyes and it is up to the caregiver to "fine-tune" infants to synchronous social engagement (Feldman, 2007). As newborns, children are responsive to facial changes and are typically tuned to their caregiver's emotional expressivity (Field et al., 1983). By 3-4 months, they can distinguish between happy, angry, fearful, sad, and surprised facial expressions (LaBarbera, Izard, Vietze, & Parisi, 1976). Young infants use facial expressions as social referencing tools and use their mother's facial expressions to interpret the world and by seven months, they are able to interpret positively and negatively valenced facial expressions and are able to anticipate what will come next (McClure, 2000; Walker-Andrews, Krogh-Jespersen, Mayhew, & Coffield, 2011). Mothers who perform certain facial expressions in an exaggerated, slow fashion are able to grab the attention of their infant and have them imitate these expressions, making social learning more likely (Fukuyama & Myowa-Yamakoshi, 2013). Throughout preschool and elementary school, children hone their abilities to recognize both basic and complex emotions (Bosacki & Moore, 2004; Tracy, Robbins, & Lagattuta, 2005). In adolescence, individuals continue to develop nonverbal decoding skills for faces (Rosenthal, 1979). Through middle adulthood, individuals are able to more accurately and sensitively recognize and discriminate nonverbal information from faces when compared to children and adolescents (Ekman, 1992; Etcoff and Magee, 1992). Sullivan, Ruffman, and Hutton (2007) posited that this may be due to adults acquiring new strategies to decode emotion expressions, such as spending more time examining features of the face (e.g., mouth) than younger adults.

Also in the visual realm of nonverbal communication is body movement. By 14 months of age, infants recognize adults pointing with fingers and directed gaze are both purposeful signals to shift attention, and by 25 months, children are able to point for themselves (Behne, Carpenter, Tomasello, 2005; Bullinger, Zimmermann, Kaminski, & Tomasello, 2011). In a study of 14-30 month year olds, mothers were able to use nods and shakes of their head to communicate confirmations or discouragements to their children, who were in turn able to interpret these signals (Fusaro, Vallotton, & Harris, 2014). The ability to decode expressive body movements, in the form of dance for example, develops later in childhood, around 4-8 years old (Boone & Cunningham, 1998).

The majority of the development of nonverbal communication seems to occur between birth and middle childhood and occurs through interactions with their caregivers. Throughout adolescence and adulthood, individuals continue to improve on the abilities they acquire in childhood. With the increase in the prevalence of technology use and if people are using technology at younger ages, the time spent using technology could be occupying time that could be spent interacting with their caregivers. Children born into an environment with high electronic technology saturation may have fewer opportunities to have face-to-face interactions with caregivers when compared to those who were born into an environment in which technology was not as prevalent. As a result, it is possible that they may have underdeveloped nonverbal communication skills. In addition, it could be that those who use more technology at older ages may also have fewer opportunities to have face-to-face interactions with others and may influence the continued development of their nonverbal communication skills.

Technology Development and Increased Prevalence of Technology Use

Individuals born between 1946 and 1964 are considered to be part of the Baby Boomers generation (Dimock, 2018). During the time of their childhood, the technological breakthrough of the time was the rotary telephone and the tube television. Since television was not as widespread as it is currently, these children may have found entertainment elsewhere, such as going outdoors with other children where they would have had exposure to nonverbal cues from their peers("The evolution of technology across generations," 2016). Individuals that make up Generation X are those born between 1965 and 1980. These children saw the uprising of the personal computer and over their lifetime, they saw the importance of technology increase as something that is necessary for everyday life (Blake, Winsor, & Allen, 2014). Finally, Millennials are defined as being born between 1981 and 1996. For Millennials, they saw the development of smartphones and portable tablets. Their exposure to technology likely began early on in their childhoods and they saw an increase in the prevalence of technology use in every day life.

Regardless of age group, technology has become increasingly integrated into everyday life as well as the prevalence of its use (Wakefield, 2015). Nonverbal communication skills typically develop within the first eight years of one's life. The Millennial generation has been exposed to technology much earlier in their lifespan when compared to Generation X and Baby Boomers, who did not have the same saturation of technology during their formative years. The differences in the prevalence of technology use over time between the Millennials and the older generations (Generation X and Baby Boomers) can be explained by the development of technology over the years.

According to a study conducted by the Pew Research Center (2015), only 12% of teens, ages 13-17, did not have a cell phone. The remaining teens (88%) had access to either a smartphone (58%) or a basic cell phone (30%) (Lenhart, 2015). This was an increase from 2013 in which 78% of teenagers had cell phones with 37% having smartphones, in particular (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013). As well as having increasing access to technology, teens are also using it more often. In the same 2015 study, 24% of teens reported going online "almost constantly" and 56% reported that they went online multiple times per day. While the 2015 study emphasized smartphone usage in teens, smartphones encapsulate only a fraction of technology usage by teens. In another study done by the Pew Research Center in 2013, it was found that 93% of teens have access to computers and 23% have tablets (Madden et al., 2013). With all of the technology that is available for teens nowadays, it is not surprising that the prevalence of use has been increasing over the last couple decades. However, older generations did not have the same electronic technology during their childhood so their percentage of technology access would be much lower.

Although younger generations had earlier access to technology, older generations are currently exhibiting the similarly high amounts of technology use. In a 2016 Nielsen survey, individuals age 35-49 showed higher smartphone usage (96%) than those aged 18-34 years (91%), ("The Neilsen Comparable Metrics Report: Q4 2016," 2017). In addition to having higher technology saturation, those in the 35-49 years of age range also reported about 21 hours of smartphone usage compared to 19 hours of smartphone uses for those in the 18-34 years of age range. It seems that all individuals are currently using the same amount of technology. However, Lauricella, Wartella, and Rideout (2015) found that parent screen time was the strongest predictor of child screen time so if parents are using more technology, their children seem to be inclined to use more technology as well. The difference between younger and older individuals may be that younger individuals used technology earlier in their lifetimes compared to older individuals.

Technology use not only includes access to technology but also the types of activities for which people are using technology. According to Cotten (2008), electronic technology use can encompass a variety of devices, such as TV, cell phones, computers, and video game consoles (e.g., Playstation, Xbox), as well as a variety of applications, such as gaming, social media, texting, email, and surfing the Internet. Longitudinal research done by Willoughby (2008) on high school students showed that online interactions are an important aspect of friendships as they found that higher friendship quality was associated with higher Internet use. This is in contrast with their previous findings that greater use of computer games was associated with lower friendship quality.

In addition to increased numbers of teens using technology, it appears that online communication and Internet use is becoming more important in creating and maintaining friendships with others. Botterill, Bredin, and Dun (2018) found that young individuals use technology predominantly for socializing and are able to use technology in order to socialize with each other at any time of the day. Technology use has perhaps become a necessity in order to have quality friendships. However, if online communication like texting or email is replacing face-to-face interactions, these teens' exposure to nonverbal communication is being limited and this may influence their nonverbal sensitivity.

In a study done in 2008, Cotten found that 71% of teens used social media and among these teens, there was a difference in that females are more likely to use visually-oriented social media, such as using Facebook to see photos and videos of other people, on their devices while males were more likely to play video games on either their smartphones or on a video game console (Cotten, 2008). Visually-oriented social media allows for exposure to facial expressions and body language. This is in contrast with gaming, surfing the Internet, and online communication (e.g. texting, email) where there are fewer chances of seeing examples of nonverbal communication. This virtual exposure to facial expressions and body language could act as a substitute to face-to-face interactions. If there is a difference in the types of technological activities used by the population, it is possible that this may increase or decrease the exposure to facial expressions and body language, which may in turn influence one's nonverbal communication development.

Technology Use During Childhood

For this current review, the technology use of infants, toddlers, and preschoolers will be the focus as much of the development of nonverbal communication skills occurs early in life. The research is only beginning to focus on technology use of this young age group as a consequence of the fact that in recent years, more electronic media has been targeted towards young children. There are TV networks for children as young as 12 months, DVDs for children from 1-18 months, and video games (Vandewater et al., 2007). As a result of allowing children to watch these TV networks and DVDs and use smartphones to play with apps, it could be limiting the amount of face-to-face interactions between caregivers and their children.

The American Academy of Pediatrics (AAP) has set guidelines of how much screen time these young children should be exposed: children younger than two years of age should avoid television-watching entirely and older children should be limited to two hours per day. They also recommend more interactive activities to promote brain development such as talking, playing, singing, and reading together. In a study done by Vandewater et al. (2007), 1051 parents were surveyed about their children's technology behavior to determine if today's children fell within the technology use guidelines set by the AAP. The results of this study revealed that 68% of children from 0-2 years old, 44% of children from 3-4 years old, and 30% of children from 5-6 years old did not fall into the range of AAP guidelines. Many children were using more technology than was recommended by the AAP. Substantial percentages of children (18%, 43%, and 37% for each age group) even had televisions in their bedrooms, which has been linked to poor academic, social, and physical activity outcomes (Saelens et al. , 2002). Some of the explanations given for bedroom television for their children were that it freed up other televisions for other family members, it keeps the child occupied, it helps the child fall asleep, and that it is a reward for good behavior. These explanations indicate that watching television is becoming a more isolated experience for all those involved. Children are growing up in an increasingly media-saturated world and if technological activities are indeed becoming more isolated, it could mean that children will have less exposure to other people. This may in turn have an effect on their acquisition of nonverbal communication skills. During the time of early childhood, children are both refining innate nonverbal abilities and acquiring new abilities through interactions with caregivers and others. If solitary technology use takes away these social learning opportunities, it could be possible that these nonverbal abilities may not develop normally for these children. Since younger individuals (i.e., the Millennial generation) had more exposure to technology at earlier ages, it could be possible that their nonverbal abilities may be weaker than those of older individuals (i.e., Baby Boomers, individuals of Generation X) who had less exposure, which leads to the basis for the present study. This study seeks to explore whether technology use at past and current time points have any influence on the relationship between age and nonverbal sensitivity.

Present Study

With increasing percentages of young children using technology during the development of nonverbal communication skills, this study attempts to explore the relationship between solitary technology use and nonverbal sensitivity. If the time spent using technology takes away from the opportunities in which a child can interact with another person and develop nonverbal communication skills, it could potentially result in underdeveloped abilities. The availability and saturation of technology has changed over the years so depending on one's year of birth, exposure to technology during childhood could range from nonexistent for older individuals to saturated for younger individuals.

In a previous study (Chen, 2017) done with college students (M_{age} = 20.41), greater amount of self-reported technology use at 12 years of age was associated with lower nonverbal sensitivity. Greater amounts of current social media usage, as opposed to technology use in which the participants were not exposed to images and videos of other people, was moderately associated with greater nonverbal sensitivity. It appeared that 12 years of age seemed to be an influential time point for when technology had a negative influence on a child's nonverbal sensitivity. But current social media use had an opposite relationship with nonverbal sensitivity. When the nonverbal measure used (DANVA-2) was divided into its subscales, it was also found that technology use at 12 years again was a negative predictor for facial expression and paralanguage subscale scores. It appeared that for the participants, who all fell in the Millennial generation, their technology use at 12 years of age had a negative relationship with their abilities to read emotions from facial expressions and from spoken language. However, current social media use was a significant positive predictor of body posture subscale scores. In this subscale, participants saw images of bodies oriented in such a way to express emotion, such as clenched fists to express anger. It could be possible that viewing other people's body language in photos and videos on social media has a relationship with improved abilities to read body language.

In this current study, the age of participants will be seen as a spectrum for the purpose of data analysis. In order to capture technology use estimates for all age groups, a wide age range of participants was acquired. It was hypothesized that (i) age would have a positive relationship with scores on a measure of nonverbal sensitivity and (ii) previous technology use, elementary school use in particular, would act as a mediator of the relationship between age and nonverbal sensitivity in that age would negatively predict previous technology use at different age points which would, in turn, predict lower nonverbal sensitivity. As much of nonverbal communication development occurs in childhood, higher amounts of elementary school technology use is hypothesized to be most impactful. It was also hypothesized that (iii) current social media use would be a mediator of the relationship between age and nonverbal sensitivity in that age would negatively predict current social media use which would in turn predict higher nonverbal sensitivity. If participants are using more social media, they could have more exposure to nonverbal cues through photos and videos and they could develop better nonverbal sensitivity in a virtual method.

Method

Participants

For this study, 152 participants (M_{age} = 39.41, SD_{age} = 13.73, age range: 19-76 years; 46% women) were recruited through Amazon Mechanical Turk and completed the study via Qualtrics. Of these 152 participants, 62.5% identified as White, 7.2% as Black, 0.7% as American Indian or Alaska Native, 25.7% as Asian, 3.3% as Hispanic, and 0.7% as Other or from multiple races. These participants were compensated $1 USD for their participation. Participants were asked an Autism Spectrum Disorder (ASD) filter question because an ASD diagnosis, which indicates a deficit in social communication, could negatively affect scores on the DANVA-2. The data for ten participants who answered "Yes" to the ASD filter question were removed from analysis. Ten participants gave unrealistic responses to the technology use portion of the study (i.e. reported more than 24 hours of technology use per day) and were also removed from analysis, resulting in a final sample of N = 132.

Measures

Diagnostic Analysis of Nonverbal Accuracy (DANVA-2).

This study assessed age differences as it predicts the Diagnostic Analysis of Nonverbal Accuracy (DANVA-2), a measure of nonverbal sensitivity (Appendix A). The DANVA-2 is a test of emotion recognition ability and measures one's ability to detect emotional cues through photos for facial expressions and body language as well as audio clips for paralanguage (e.g., tone of a sentence) (Nowicki & Duke, 2001). The participants were given a set of 24 photos each for facial expressionsand body language and a set of 24 audio clips for paralanguage. They needed to interpret each photo or audio clip for one of four basic emotions: *happiness*, *sadness*, *anger*, and *fear*. After each photo or audio clip, the participants were given the four basic emotions in the form of a multiple-choice question as to which emotion was depicted. The scores from the DANVA-2 were used as a representation of the participants' nonverbal sensitivity with a maximum score of 72 for a DANVA-2 total score. The DANVA-2 can be divided into three subscales, each with a maximum score of 24: facial expressions, body postures, and paralanguage. The three subscales measured one's ability to interpret emotions from different domains of nonverbal communication. Higher scores on the DANVA-2 indicate higher nonverbal sensitivity (i.e., a better ability to interpret emotions from nonverbal behaviors). Higher scores on the DANVA-2's subscales indicate a better ability to interpret emotions from facial expressions, body postures, and paralanguage.

Technology use survey.

A technology use survey was developed for this present study for participants to self-report the amount of time they engaged in solitary technology activities at various ages (Appendix B). A similar scale was previously used in a study to measure social media use (Sidani, Shensa, Hoffman, Hanmer, & Primack, 2016). Solitary technological activities were defined for the participants as the use of technology when it is used by oneself, not a shared experience with another person, on any platform of technology (e.g. computers, smartphones, consoles). Participants were asked about their solitary technology use at three different time points in their life: elementary school (6-10 years of age), middle school (11-14 years of age), and high school (15-18 years of age). They were told to estimate the amount of time, in hours per day, that they spent using technology, on any electronic device, such as watching television, using a computer, using a smartphone, playing video games (Gameboy, Playstation, Xbox), etc. They were asked to give separate estimates for the number of hours per day on weekdays and on weekends as the type of technological activities may differ from weekdays to weekends. With the estimate for weekdays and weekends, a weighted average number of hours per day over a typical week was calculated for each participant.

For current technology use, solitary technological activities were divided into two groups: non-social activities and social media activities. Non-social activities included activities such as single-player games, school work, email, and browsing the Internet and included technology used at home, at work, and at school. Social media activities included activities that involve looking at others through a platform such as Facebook, Instagram, Snapchat, etc. The definitions of non-social activities and social media activities were provided for the participants. The reason for separating technological activities was that in social media activities, people are exposed to others' facial expressions and body language that could be a form of interaction from which they can develop nonverbal communication perception. As with previous technology use estimates, an average number of hours per day over a typical week was calculated for each participant from their estimates of weekday and weekend use.

Procedure

Participants were recruited through Amazon Mechanical Turk and if they met the age requirement set for the survey, they were told they would be participating in a study about nonverbal communication skills. First, they completed the DANVA-2 and then the technology use questionnaire. Following the technology use questionnaire, the participants answered several demographic questions.

The demographic questions included age, ethnicity, education level, gender, and an ASD diagnosis filter question. Finally, the participants were thanked and then compensated for their participation.

Results

A mediated regression analysis was conducted with age as a predictor variable, technology use per day at past and current time points as mediators, and DANVA-2 scores as the outcome variable. Four separate mediated regressions were conducted with the DANVA-2 total score as the outcome variable and then with each of the three DANVA-2 subscales as the outcome variable: facial expressions, paralanguage, and body postures.

Mediated Regression with DANVA-2 Total Score as Outcome

A bootstrap analysis was conducted with 5000 bootstrap samples with DANVA-2 total scores as the outcome variable. The distribution of DANVA-2 total scores was negatively skewed, indicating that participants tended to score higher on the DANVA-2 with fewer low scores (M_{Total} = 51.89 out of a possible 72, SD_{Total} = 8.08). The total effect of age on DANVA-2 total scores was significant, c = 0.22, t = 4.84, p < .001 and remained significant even after all five hypothesized mediators were added to the model, c' = 0.18, t = 3.75, p < .001. The total indirect effect of the five mediators was not significant, Indirect B = 0.04 [95% BCa CI: -0.02, 0.09]. As seen in Figure 1, elementary school use and current social media use were significant and positive mediators in that age negatively predicted both elementary school use and current social media use, and in turn, both variables negatively predicted DANVA-2 total score ([95% BCa CI: 0.00, 0.10]; [95% Bca CI: 0.02, 0.09]).

Mediated Regression with DANVA-2 Facial Expression Subscale as Outcome

A bootstrap analysis was conducted with 5000 bootstrap samples with DANVA-2 facial expression subscale scores as the outcome variable. The distribution of DANVA-2 facial expression subscale scores was negatively skewed, indicating that participants tended to score higher on the DANVA-2 with fewer low scores (M_{Total} = 19.02 out of 24, SD_{Total} = 2.62). The total effect of age on DANVA-2 facial expression subscale scores was significant, c = 0.07, t = 4.45, p < .001 and remained significant even after all five hypothesized mediators were added to the model, c' = 0.05, t = 3.13, p = .002. The total indirect effect of the five mediators was significant, Indirect B = 0.02 [95% BCa CI: 0.00, 0.03]. As seen in Figure 2, elementary school use and current social media use were significant and positive mediators in that age negatively predicted both elementary school use and current social media use, and in turn, both variables negatively predicted DANVA-2 facial expression subscale score ([95% BCa CI: 0.00, 0.04];[95% BCa CI: 0.00, 0.02]).

Mediated Regression with DANVA-2 Paralanguage Subscale as Outcome

A bootstrap analysis was conducted with 5000 bootstrap samples with DANVA-2 paralanguage subscale scores as the outcome variable. The distribution of DANVA-2 paralanguage subscale scores was negatively skewed, indicating that participants tended to score higher on the DANVA-2 with fewer low scores (M_{Total} = 16.11 out of 24, SD_{Total} = 3.66). The total effect of age on DANVA-2 paralanguage subscale scores was significant, c = 0.07, t = 3.53, p < .001 and remained significant even after all five hypothesized mediators were added to the model, c' = 0.07, t = 2.85, p = .005. The total indirect effect of the five mediators was not significant, Indirect B = 0.01 [95% BCa CI: -0.02, 0.04]. As seen in Figure 3, only current social media use was a significant and positive mediator in that age negatively predicted current social media use, which in turn, negatively predicted DANVA-2 paralanguage subscale scores ([95% BCa CI: 0.01, 0.04]).

Mediated Regression with DANVA-2 Body Posture Subscale as Outcome

A bootstrap analysis was conducted with 5000 bootstrap samples with DANVA-2 body postures subscale scores as the outcome variable. The distribution of DANVA-2 body postures subscale scores was negatively skewed, indicating that participants tended to score higher on the DANVA-2 with fewer low scores (M_{Total} = 16.76 out of 24, SD_{Total} = 3.40). The total effect of age on DANVA-2 body postures subscale scores was significant, c = 0.08, t = 4.03, p < .001 and remained significant even after all five hypothesized mediators were added to the model, c' = 0.07, t = 3.11, p = .002. The total indirect effect of the five mediators was not significant, Indirect B = 0.01 [95% BCa CI: -0.01, 0.03]. As seen in Figure 4, only current social media use was a significant and positive mediator in that age negatively predicted current social media use, which in turn, negatively predicted DANVA-2 body postures subscale scores ([95% BCa CI: 0.00, 0.03]).

Discussion

From the results of this study, the first hypothesis that age would have a positive relationship with scores on a measure of nonverbal sensitivity was supported. Younger participants scored lower on the measure of nonverbal sensitivity than older participants. The second hypothesis that previous technology use, elementary school age technology use in particular, would act as a mediator of the relationship between age and nonverbal sensitivity was also confirmed. Of the previous age point technology use mediators, elementary school age technology use was the only significant mediator of the relationship between age and nonverbal sensitivity. Younger individuals used more technology at elementary school ages, and this, in turn, predicted lower nonverbal sensitivity. After dividing the DANVA-2 into its subscales, it also appears that elementary school age technology use was a significant mediator of the relationship between age and nonverbal sensitivity to facial expressions. Younger individuals used more technology at younger ages and this technology use predicted lower abilities to interpret emotions from facial expressions.

Nonverbal communication is used more readily to communicate social and affective-based constructs and cannot be self-regulated as well as verbal communication (DePaulo, 1992). Being able to accurately interpret another's nonverbal cues allows for one to interpret interactions with others more richly. If this technology use has an impact on one's nonverbal sensitivity, it could take away from the social and emotional component in interactions between people. The findings of this study showed that the younger participants spent more time using technology during elementary school ages, which then negatively predicted their ability to read emotions from nonverbal behaviors.

The older participants did not have the same technology saturation in their childhood as the younger participants and this might explain why age was related with lower amounts of elementary school age technology use. The younger participants, who used more technology at this younger age point, showed lower nonverbal sensitivity. This is in contrast with prior studies that found that 2nd grade children who watched more television were better at decoding others' nonverbal expressions (Feldman, Coats, & Spielman, 1996). Perhaps since the younger participants spent more time using technology in their childhood, opportunities to have face-to-face interactions with others were limited and they were not able to develop their nonverbal communication skills as well as the older participants. Although middle school (11-14 years of age) and high school (15-18 years of age) technology use did not significantly mediate the relationship between participant's age and nonverbal sensitivity, use during elementary school (6-10 years of age) was significant. This suggests that elementary school ages may be an important time for the development of nonverbal communication skills. As seen in Keating's overview of nonverbal communication (2016), development of nonverbal communication skills occurs from birth to eight years of age. Based on the results of this study, increased technology use at this age point seems to interfere with the development of nonverbal sensitivity.

While elementary school age technology use was a significant mediator in the relationship between age and nonverbal sensitivity as a whole, the amount of time spent on technology at elementary school ages was a significant mediator of the relationship between age and one's ability to interpret emotions from facial expressions but not from paralanguage and body postures. It seems some aspect of technology use at elementary school ages is negatively associated with one's development of sensitivity to facial expressions. It could be possible that the type of technology that people are using at elementary school ages influences the development of facial expression recognition. Coats and Feldman (1995) found that school-age children who watched more television were able to nonverbally communicate happiness and sadness better than disgust and fear/surprise because happiness and sadness were more common on television. If television is associated with different sensitivities to different nonverbal emotions, it could be that technology use is also associated with different sensitivities in the different domains of nonverbal communication. Future research will be needed to determine why only ability to determine emotions from facial expressions were influenced and not from paralanguage and body postures.

However, the third hypothesis that current social media use would be a mediator of the relationship between age and nonverbal sensitivity in that age would negatively predict current social media use, which, would in turn predict higher nonverbal sensitivity was not confirmed. Although current social media use was a significant mediator of the relationship between age and nonverbal sensitivity, higher current social media use actually predicted lower nonverbal sensitivity. Younger individuals used more social media and this predicted lower abilities to interpret emotions from nonverbal behaviors. When the DANVA-2 was divided into its subscales, current social media use continued to be significant mediators on the relationship between age and all three subscales of ability to recognize emotions from facial expressions, paralanguage, and body postures. Younger individuals used more social media and it predicted lower abilities to interpret emotions from facial expressions, spoken language, and body language.

It was initially theorized that participants would have higher nonverbal sensitivity after using higher amounts of social media because of the exposure to facial expressions and body language through photos and videos acting as a substitute for face-to-face interactions with others. Younger participants did indeed use more social media but social media use did not positively predict nonverbal sensitivity. In fact, the more social media use the participant used, the lower their nonverbal sensitivity and this applied across all three subscales: ability to recognize emotions from facial expressions, paralanguage, and body postures. Perhaps it is because people tend to curate their social media content (Chua & Chang, 2016). They select photos and videos in which they seem happy and make their lives enviable. If this content is what people see when they use social media, it's possible that they only see happiness. The DANVA-2 measured one's ability to recognize the emotions of *happiness, sadness, anger,* and *fear* and if people tend to only see happiness in social media, it could be that their ability to recognize sadness, anger, and fear are not as strong. As a result, social media was negatively associated with one's nonverbal sensitivity. Another possibility is that those who have lower nonverbal sensitivity use more social media use instead of those who use more social media have lower nonverbal sensitivity. Mahmud, Ramachanidiran, and Ismail (2018) found that students rely on social media so they can portray themselves differently or be less shy. They also were inclined to resort to social media when in social situations. If social media is being used to curate one's appearance and behavior, those who have lower nonverbal sensitivity may use more social media in order to maintain a certain image or to avoid social awkwardness.

This study was not without limitations. As this study asked participants to recall technology use from their childhood years, it was to be expected that there would be recall inaccuracies. The estimates of technology use could be underestimations or overestimations of how much technology a participant actually used. Also with how frequently people use smartphones nowadays, it is difficult to estimate the total amount of time currently spent using technology. It would be difficult for a participant to say definitively the total amount of time per day if they check their phone every couple minutes. For accurate reporting of amount of technology use, it may be required in future studies to install software, such as Moment or Offtime, that track how much time a person is spending on their phone. Moment has previously been used in a study by Elhai et al. (2018) to measure the daily smartphone use of students over the course of one week. The use of a smartphone application like Moment in a study similar to the current study would allow for accurate reporting of smartphone usage.

If elementary school age technology use and current social media use are indeed significant mediators in the relationship between age and nonverbal sensitivity, it would provide a basis for future studies. The types of technological activities people are engaging in at elementary school ages should be explored since this age point seemed to be influential on one's nonverbal sensitivity. An aspect of technology use, whether it be amount or type of activity, is influencing one's nonverbal sensitivity in such a way that it has an association with nonverbal sensitivity to facial expressions but not with paralanguage or body postures. Future research could be conducted to explore why only one aspect of nonverbal communication is influenced. Current social media use should also be further researched. In a survey conducted by Oblinger (2003), it was found that millennials no longer consider computers to be technology as it is assumed to just be a part of life and that staying connected, via multiple devices, at all times is essential. If current social media use is negatively associated with nonverbal communication skills and younger individuals are now viewing technology as an essential part of life, the effects of using social media should be explored. Bleakley, Piotrowski, Hennessy, and Jordan (2013) found that the beliefs that limiting television for children is beneficial for school and family dynamics as well as an increased awareness that other parents are also trying to limit their child's television time (i.e., normative pressure, creating a social norm about the importance of limiting viewing) were the strongest predictors for parents to have the intention of limiting screen time for their children. If people are able to develop the intention to limit the amount of technology they are using, it could lower the amount of technology use and allow for more opportunities for face-to-face interactions which could, in turn, allow for more development of nonverbal communication.

Technology is becoming increasingly prevalent in everyday life and with more electronic media being targeted towards young children, it seems that technology use among younger individuals will only increase. But if technology use at younger ages does have a negative relationship with on one's nonverbal communication development, then it should be explored whether amount of technology use at younger ages should be limited in order to increase the amount of time that is being spent interacting face-to-face with others. The same can be said for current social media use. If technology use is taking away from one's ability to utilize nonverbal behaviors in communication, it could affect how richly people are able to communicate with each other.

As technology will only become more integrated in everyday life, it would be prudent to continue research on the effects of technology use on one's nonverbal communication skills.

Appendix A

Facial Expressions Subscale from DANVA-2 (Nowicki & Duke, 2001)

Body Postures Subscale from DANVA-2 (Nowicki & Duke, 2001)

Appendix B

PREVIOUS TECHNOLOGY USE: To the best of your recollection, approximately how much time per day (*in hours*) do you think you spent on solitary technological activities (activities done by oneself and not with another person) when you were in **elementary school (6-10 years of age)/middle school (11-14 years of age)/high school (15-18 years of age)?**

This may include activities, on any electronic device, such as watching television, using a computer, using a smartphone, playing video games (Gameboy, Playstation, Xbox), etc.

Average number of hours per day on weekdays: _____
Average number of hours per day on weekends: _____

CURRENT SOCIAL TECHNOLOGY USE: In the **last 6 months**, approximately how much time per day (*in hours*) do you think you spent on Social Media?

This may include time spent on Facebook, Instagram, Snapchat, Youtube, etc. on any electronic device.

Average number of hours per day on weekdays: _____
Average number of hours per day on weekends: _____

CURRENT NON-SOCIAL TECHNOLOGY USE: In the **last 6 months**, approximately how much time per day (*in hours*) do you think you spent on solitary technological activities (activities done by oneself and not with another person)?

This may include time spent on television, single-player games (Gameboy, Playstation, Xbox), school work, email, Internet, etc. on any electronic device. This would include time **at home, at work, and at school.**

Average number of hours per day on weekdays: _____
Average number of hours per day on weekends: _____

Demographics

1. What is your age in years? _____
2. Please specify your ethnicity.
   ☐White
   ☐Black or African American
   ☐American Indian or Alaskan Native
   ☐Asian
   ☐Native Hawaiian or other Pacific Islander

☐Hispanic
☐Other or from multiple races, please specify.

3. Are you male or female?
☐Male
☐Female
☐Other, please specify.

4. What is the highest educational level you have achieved?
☐Less than high school
☐High school graduate
☐Some college
☐Associate's
☐Bachelor's
☐Professional degree
☐Master's
☐Doctorate

5. Have you ever received an Autism Spectrum Disorder diagnosis?
☐Yes
☐No

Appendix C

Institutional Review Board Approval

IRB Approval 1710024106 Inbox x

IRB <irb@towson.edu> 10/20/17

to me, Maria

The IRB has approved your protocol "**Generation Differences in the Effect of Technology Use on Nonverbal Communication" as exempt, effective 10/20/2017.**

Your IRB protocol can now be viewed in MyOSPR. **Student investigators: protocols can be viewed by your faculty advisor.** For more information, please visit: http://www.towson.edu/academics/research/sponsored/myospr.html

Please Note: *Formal approval letters are now provided upon request. If you would like to have one drafted, please notify the IRB staff.*

If you should encounter any new risks, reactions, or injuries to subjects while conducting your research, please notify IRB@towson.edu. If your research has been approved as expedited and will extend beyond one year in duration, you will need to submit an annual renewal notice. Should there be substantive changes in your research protocol, you will need to submit another application.

Regards,
Towson IRB

Appendix D

Informed Consent Form

Informed Consent

Principal Investigator: Belinda Chen, Department of Psychology, Towson University

This is a study in which we are examining the relationship between technology use and nonverbal communication. If you choose to participate, you will first complete a measure of nonverbal sensitivity, which consists of a series of photos of facial expressions, body postures, and audio clips of paralanguage and will ask you to identify each emotion. Afterwards, you will be asked questions about previous and current technology use.

The study should take about 20 minutes to complete and you will receive $0.50 as compensation. Your participation is entirely voluntary. There are no known risks associated with participating in the study. However, should you become distressed or uncomfortable, please close out of the survey link and email the principal investigator.

Participants must be at least 18 years old.

All information about participants' responses will remain strictly confidential and anonymous. We will not show your personal information to anyone outside of our research team. Although descriptions and findings may be published, no publications or reports from this project will include identifying information on any participant.

If you should have questions regarding the study, you can email me at bchen4@students.towson.edu, my faculty advisor Dr. Maria Fracasso at fracasso@towson.edu or contact Dr. Elizabeth Katz, Chairperson of the Institutional Review Board for the Protection of Human Participants at Towson University, at (410) 704-3207.

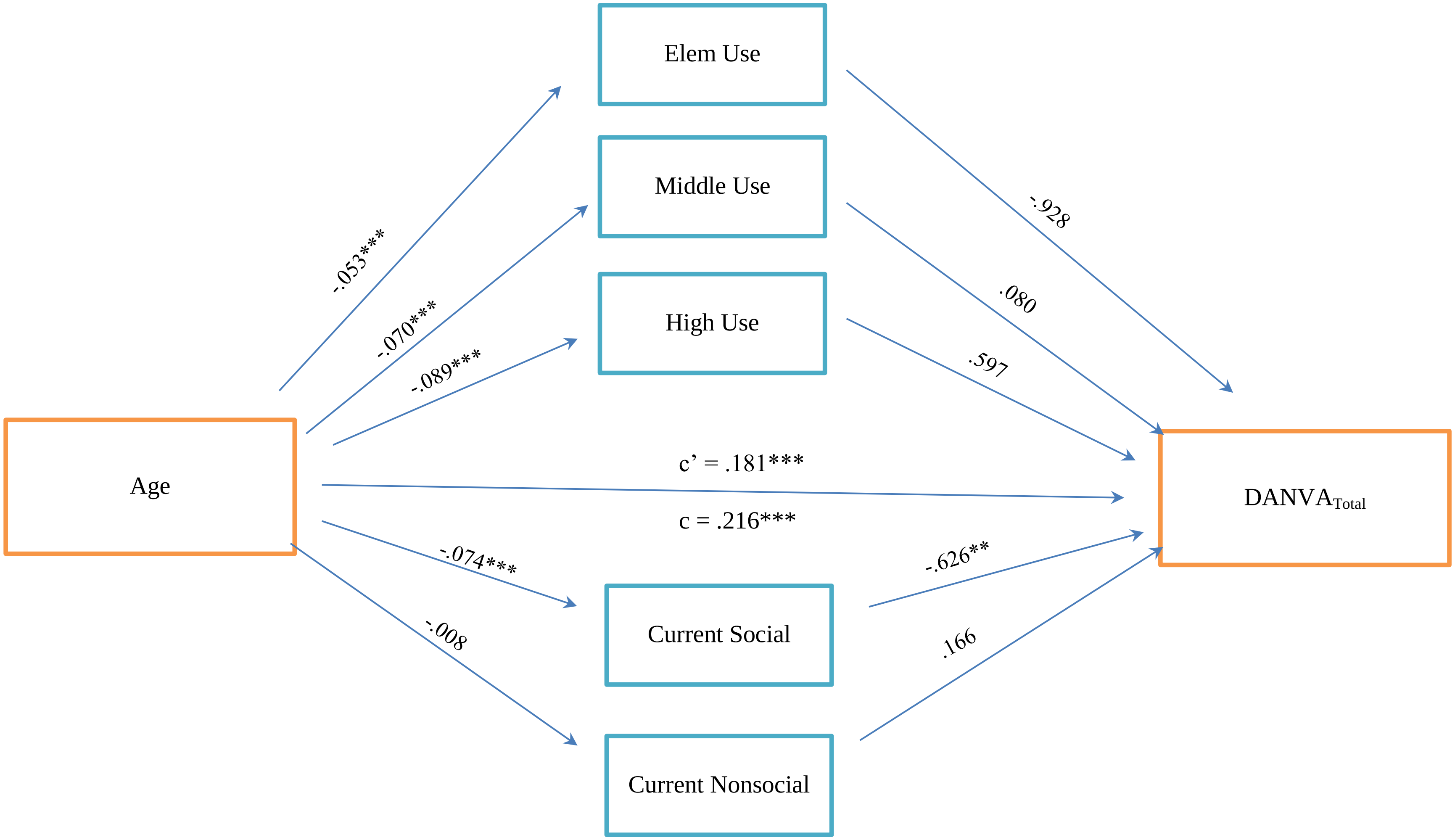
By choosing "I assent" below, I affirm that I have read and understand the above statements.

I assent

I do not assent

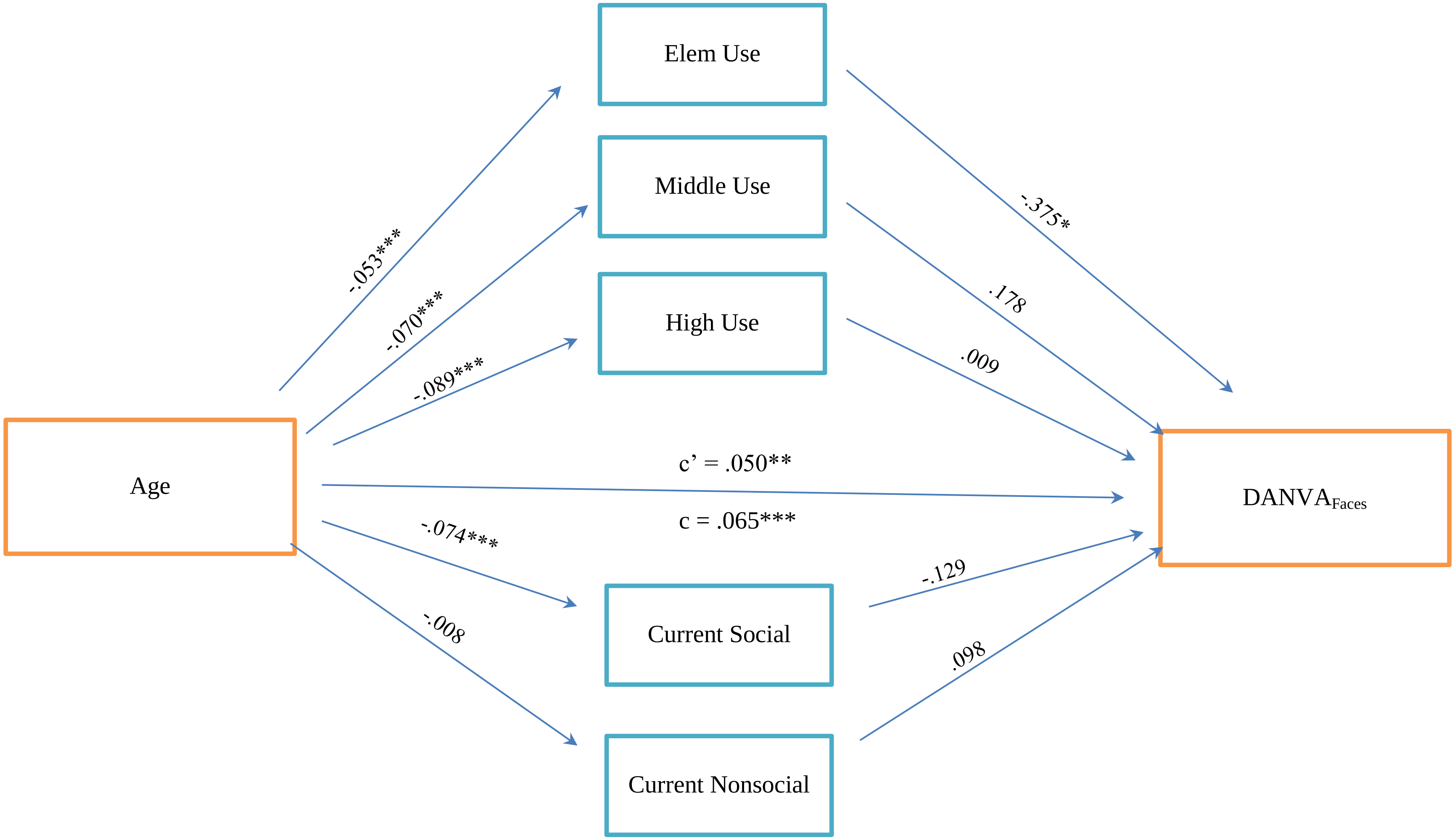
>>

Powered by Qualtrics



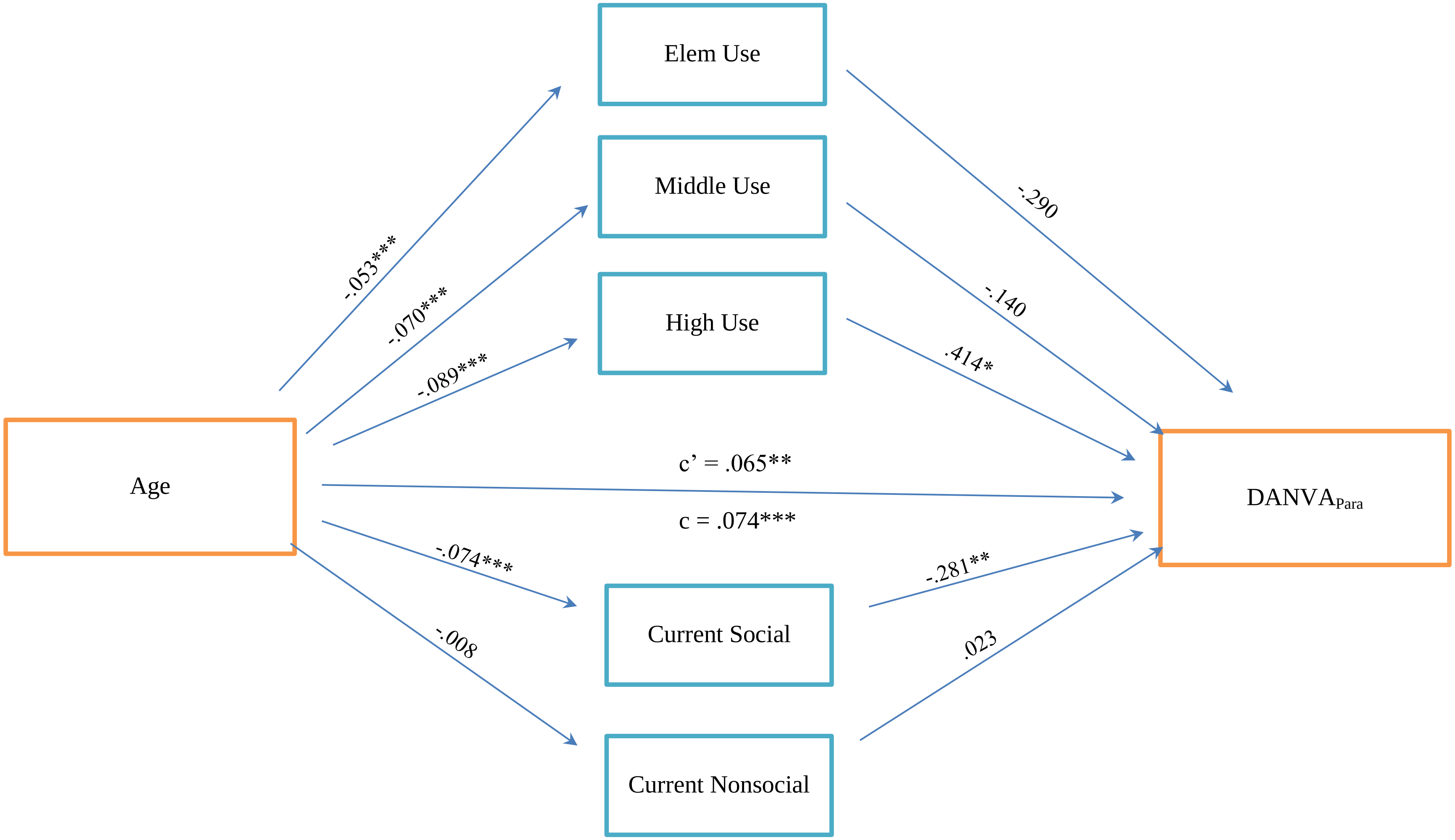
*: p < .05; **: p < .01; ***: p < .001

Figure 1. Mediated Regression Analysis with DANVA-2 Total Score as Outcome Variable.



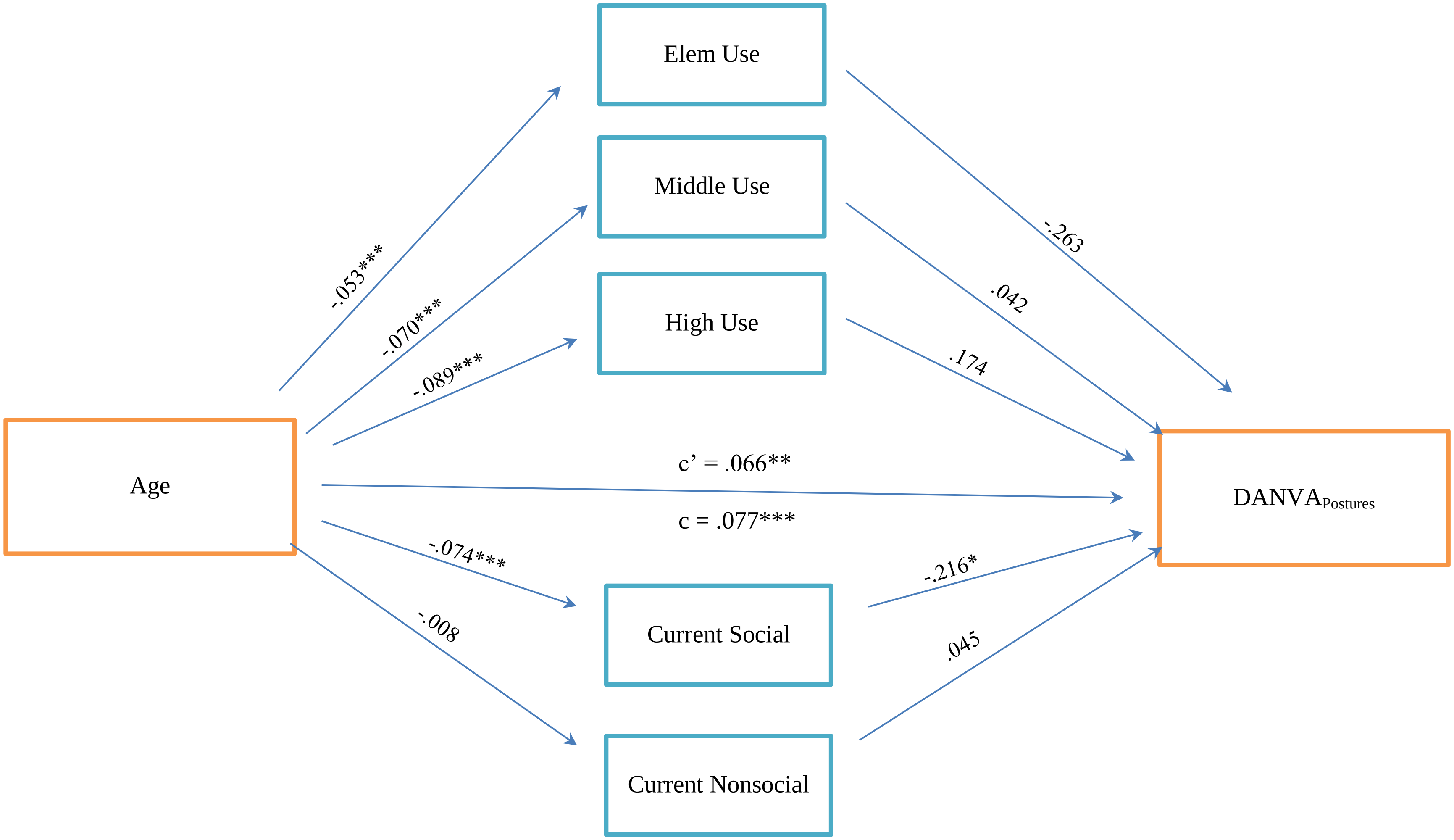
*: p < .05; **: p < .01; ***: p < .001

Figure 2. Mediated Regression Analysis with DANVA-2 Facial Expressions Score as Outcome Variable.



*: p < .05; **: p < .01; ***: p < .001

Figure 3. Mediated Regression Analysis with DANVA-2 Paralanguage Score as Outcome Variable.



*: p < .05; **: p < .01; ***: p < .001

Figure 4. Mediated Regression Analysis with DANVA-2 Body Postures Score as Outcome Variable.

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Belinda Chen

Education

2016-Present	**M.A., Experimental Psychology**, Towson University, Towson, MD GPA: 3.67 Thesis title: *"The Relationship Between Technology Use and Age Differences on Nonverbal Sensitivity"* Advisors: Drs. Maria Fracasso (chair), Jeffrey Kukucka, Jessica Stansbury
2010-2014	**B.S., Psychology, University of Michigan**, Ann Arbor, MI GPA: 3.69 Minor in Applied Statistics

Relevant Coursework

PSYC 680 Advanced Cognitive Psychology
PSYC 682 Advanced Social Psychology
PSYC 681 Advanced Experimental Design I
PSYC 688 Advanced Experimental Design II
PSYC 689 Multivariate Methods
PSYC 674 Advanced Biological Psychology

Conference Presentations

Chen B. & Fracasso, M.P. (2018, April). *Influence of Age Differences and Technology Use on Nonverbal Communication Skills.* Poster presented at the 2018 Psychology Graduate Student Association Conference, Towson. MD.

Chen B. & Leigh A. (2018, March). *Emotion Regulation and Moral Judgment*. Poster presented at the 2018 Eastern Psychological Association meeting, Philadelphia, PA.

Carson D., **Chen B.**, Parton D., McGinley J. (2017, April). *Palpitations, perspiration, and pity: The physiological and affective consequences of social inclusion, rejection, and vicarious ostracism*. Poster presented at the 2017 Towson University Student Research & Creative Inquiry Forum, Towson, MD.

Research Experience

2017-Present	**Primary Investigator**, "The Relationship Between Technology Use and Age Differences on Nonverbal Sensitivity" Master's Thesis, Towson University, Towson, MD
2016-17	**Primary Investigator**, "Studying the Relationship Between Early Technology Use and Nonverbal Sensitivity" Towson University, Towson, MD

Other Research Experience

2018-Present	**Research Assistant**, Teaching and Gaming Lab Towson University, Towson, MD
2013-2014	**Research Assistant**, Emotions & Illusion of Choice Lab University of Michigan, Ann Arbor, MI

Grants & Awards

2018	Graduate Student Association Travel Award
2018	Graduate Student Association Research Award
2017	Graduate Student Association Research Award

Professional Experience

Jan 2015-Present

Data Entry Specialist, Center of Autism and Related Disorders
Kennedy Krieger Institute, Baltimore, MD
Process data from research experiments as well as from the clinic, construct databases for studies, and assist with coding projects based on parent behavior.

Nov 2014-Mar 2015

Research Contractor, Tiltfactor
Dartmouth College
Conducted literature reviews for impending papers and books about psychological applications of video games and card games.