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Abstract

Objective: One factor that influences movement patterns in adults is perceived risk. While prior studies have established that children are able to recognize risk factors, it is not clear whether they are able to translate that knowledge into changed patterns of motion.

Method: 27 girls aged 7 to 9 years were asked to reach for plastic and porcelain teacups in the context of a "tea party" scenario. Their movements were captured and analyzed.

Discussion: No differences were found in most variables, and effect sizes were small. This may be due to the girls' immature motor-planning skills, their inability to accurately perceive risk, or the inherent delicacy of movement evoked by the situation.

Conclusion: Future research is needed to clarify the age at which children incorporate perceived risk into motor planning. This study points to the need for careful consideration of the various elements of the occupational form in such studies.

The Effects of Perceived Risk on the Quality of Occupationally-Embedded Movements in Females Aged 7 to 9 Years

Occupational Therapists (OTs) are thought to have a great influence on the lives of the people they treat. Their clients range from neonates in the Intensive Care Unit to senior citizens in hospice care. However, a major population that receives Occupational Therapy (OT) is the school-based pediatric population. These OTs help students with intellectual, physical, and psychological disabilities and needs. Goals are often associated with learning objectives via Individualized Education Plans. Beyond schools, OTs treat children in settings such as hospitals, rehab clinics, and mental health facilities whose goals may not be tied specifically to education goals, but, rather, address broader life skills and underlying physical abilities. It is this latter situation that is the focus of this study.

From a biological perspective, humans gather information about their environment through their sensory organs: skin, eyes, ears, etc. This information is transmitted through sensory pathways to the central nervous system ("About Occupational Therapy" ; Luria, 1974). Some automatic reactions are processed in the spinal cord, but the more sophisticated reactions are developed when the signals continue on to the association areas of the brain. It is in these association areas where the signals are processed and meaning-making happens as current sensory information is connected to previous experiences and patterns of knowledge. Once a response has been formulated, motor commands are sent down the relevant motor pathways to the muscles needed to enact the response. These processes are dependent on the integrity of the nervous system, which may be compromised at various points, and in a variety of ways. More relevant, however, is the process by which the nervous system initially develops. Although humans' brains reach more or less their adult size by age 5, neural connections proliferate and are pruned back in different areas at different points during development, with the prefrontal cortex continuing to develop into early adulthood (Casey, Giedd, & Thomas, 2000). This area is associated with executive functioning, such as decision-making, attention, and inhibition. Meanwhile, the basal ganglia, an area associated with coordination, continues to grow until late childhood (Lenroot & Giedd, 2006). Because children's brains are still developing, their responses may be different than adults' for reasons having more to do with biology than life experiences.

This process can also be understood through Nelson's Conceptual Framework for Therapeutic Occupation. Raw sensory data are made useful by what Nelson refers to as symbolic perception, wherein the person interprets the sensory input and makes it meaningful, based on the person's own internal processes, knowledge, and beliefs. It is this individual interpretation to which people react, rather than to the "objective" reality of a situation, or even the generally-agreed-upon interpretation of the culture in which they live. This process of meaning-making, however, is entirely opaque to outside observers, so meanings must be inferred through the occupational performances of the individual and the impacts they have. These can take the form of self-report, in which the person explains their perception, or by observing the person's motoric occupational performances, which can be particularly useful in cases where the self-report may be unreliable or the practical effects of changes in the occupational form are being studied. One of the differences that can be observed is quality of movement, which has been shown to vary under different conditions.

One of the most well-established of these differences is between goal-oriented motions, as opposed to rote exercise. This difference, of course, is central to Occupational Therapy, which, according to the American Occupational Therapy Association promotes the "use of everyday activities (occupations)" ("About Occupational Therapy"). Reaching for an item, rather than an empty spatial location has been consistently shown to lead to better quality of movement. In healthy female university students, picking up a pencil to write their name led to faster, smoother, and more direct movement, compared to pretending to do so or rote arm movement (C. Wu, Trombly, & Lin, 1994). Trombly and Wu (1999) compared the movements of people who had had a stroke when reaching for an empty space to when they reached for a food item. In the second condition, they showed "significantly smoother, faster, more forceful, and more preplanned movement." Although the evidence in normally-functioning children is lacking, children with spastic hemiplegia showed "faster, smoother, and better controlled" movements when reaching for a functional light switch than when the light switch was non-functional or they were asked to reach for a spot on the table (Volman, Wijnroks, & Vermeer, 2002). This difference was particularly evident when the children used their affected arms.

Preference has also been shown to have an effect. Bakshi, Bhambhani, and Madill (1991) found that healthy university students, when asked to perform the tasks they selected as most and least preferred out of eight options, their perceived level of exertion was less for their preferred activity. They also reported that many of the subjects said that, had they not been required to do the least-preferred activity for a set amount of time, they would have stopped sooner. Wu, Wong, Lin, and Chen (2001), asked 27 people who had had strokes to reach for beverages which they had ranked their most and least favorite from among five. They found that reaching for the most-preferred drink took less time, both in reaction time and movement time. Although evidence for this effect in children is lacking, it is still worth taking into consideration.

A third relevant factor is degree of perceived risk. Rice and Thomas (2000) found that healthy adults took more time and had greater displacement and movement units when pouring hot water than cold water, indicating less efficient, slower, and more careful movements. This finding was supported when the experiment was replicated with healthy older adults, who took more time and made more adjustments when pouring hot water (Thomas & Rice, 2002). Fuller, Thomas, and Rice (2006) found that persons with cerebrovascular accidents took more time to move a raw egg than a plastic egg. These findings indicate that therapists can induce differing speeds of movement by providing materials with different levels of risk.

New parents are advised to “baby-proof” their homes, including moving or removing breakable objects (Ferrer-Chancy, Fugate, and Gouin, 2003). The justification for this practice is that very young children do not perceive inherent risk and can easily be injured before they learn the difference between things that are safe or unsafe to handle. This model, of keeping delicate objects out of reach for children, continues in other settings, such as daycare, school, and therapeutic environments, even as children mature enough to recognize risk and better control their movements.

Motor control, like most skills, develops as children mature. According to the theories of Nikolai Bernstein, this control develops as the child tries different strategies and receives feedback from the environment (Gurfinkel & Cordo, 1998). There are a huge number of ways that a person could perform a movement like reaching for an object, but, as children grow and develop, they refine their strategies until they have a highly-efficient, adult reach. This theory is borne out by experimental evidence. When asked to reach for and move an item at a set pace, 9-10 year old children showed the most adult-like patterns of control as well as the most consistency of speed (Traynor, Galea, & Pierrynowski, 2012). 5-6 year old children showed less control and less consistency. It is reasonable to wonder whether these children would have the motor skills necessary to “be careful” in all situations.

The other aspect of response to risk that must be considered is whether children are able to reliably recognize risk. When presented with a pairs of photographs showing more and less risky versions of an activity (bike-riding, going down stairs, playing on a playground), children aged 6, 8, and 10 were all equally able to identify the more risky scenario the vast majority of the time (Gillier & Morrongiello, 1998). Younger children took longer, identified fewer risk factors, and suggested fewer preventive measures than older children. Gillier & Morrongiello also found that girls rated situations as more dangerous than boys, judgments apparently based on "perceived vulnerability to injury" rather than "judged severity of injury". Thus, within this age group, girls are more likely to be sensitive to the risk in a situation.

The purpose of this study is to examine the influence of the perception of risk on the motion dynamics of a contextually relevant reaching task in children. Based on previous research, older girls without physical disabilities should be the sub-set of that group who would be most likely to show an effect, if any do. Results from occupationally-embedded movements should have greater validity for real-world application than rote movements. Thus, we hypothesize that movement efficiency will be better in a low-risk occupationally-embedded condition than in a similar high-risk condition for healthy girls aged 7-9 years.

Method

Participants

Participants comprised a total of 27 girls in second and third grades (ages 7-9 years, mean 8.27 years). Data from five of them were not successfully collected due to equipment error. They were recruited through Girl Scout Brownie and other community organizations, as well as after-school programs. Exclusion criteria were: physical disabilities limiting the ability to sit and reach, inability to understand spoken English-language directions, and cognitive disabilities that would adversely affect her ability to participate in this research. Participants were offered a 'participation patch' that can be worn on their organizational vest, sash or other clothing.

Apparatus

Video data were collected using a black and white Basler B94 100 Hz digital camera, suspended from a wooden frame 28.5 inches above the working surface. MaxTraq motion analysis software (version 2.2.2.2, Innovision Systems Inc) was employed for both data collection and data analysis and was installed on a Dell Latitude E6510 laptop computer. The MaxTraq software uses a window resolution of 460 X 344 (Y and X pixels). To aid in digitizing motion, reflective tape was placed on the dominant hand of each participant to allow for detection of movement.

Dependent variables and statistical analysis plan

Motor performance was assessed through the motion analysis variables of movement time, movement displacement, velocity, and movement units. Motion variables were derived from the digitized X-Y position/movement trajectories of key points. The positional data were collected using a 2-dimensional system that records data in the X and Y plane, with the X-axis running medial and lateral and the Y-axis running anterior and posterior and used a pixel resolution of 460 (y) by 344 (x). The dependent variables were calculated from the time the participant initially moves from her starting point and ended when the tea cup is moved. The resolution of the X and Y position data was calculated for each sample (e.g., $\sqrt{x^2 + y^2}$). Displacement was calculated by summing the absolute position difference from sample to sample from the start to the stop points of the trial (Holubar & Rice, 2006). The only dependent variable whose data passed tests of normality was peak velocity, thus a one-tailed paired *t*-test was used for that variable, while the rest were analyzed with one-tailed Wilcoxon Signed Ranks tests. Cohen's *d* was calculated for all comparisons (Cohen, 1988).

Randomization

Randomization of the presentation of conditions was employed to control for order effects. Specifically, participants were randomly assigned to one of four possible presentation of order groups; namely, Left Porcelain, Left Plastic, Right Porcelain, and Right Plastic. A custom software program generated the randomization and involved permutated blocks involving 3 blocks of 8, and 4 blocks.

Procedure

This study was approved by the Biomedical Institutional Review Board of The University of Toledo (IRB #107928). Informed consent was obtained from each participant and her legal guardian prior to any data collection. Data collection occurred from July 2012 through April 2013. The portable nature of the apparatus allowed the sessions to take place in community settings familiar to the subjects. A portable table with a surface 5 inches off the ground was set up under the apparatus, then covered with a tailored tablecloth. On the side farthest from the door, a wooden tray was set at an angle, such that it is to the right of a person sitting on that side of the table, but was comfortably accessible to that person. On the tray were an empty porcelain teapot, an empty plastic cream pitcher and porcelain sugar bowl, and 4 teacups. Two of the teacups were plastic and two were porcelain. They were otherwise of equivalent size and appearance. Two stuffed animals, wearing hats and shawls were placed on the flanking sides of the table. The side nearest the door was for the participant.

There was small collection of fancy hats and shawls, from which the participants were offered the opportunity to select something to wear to the tea party, if they wished, and then joined the researcher at the table.

The researcher then picked up the first teacup (order determined by randomization before the trial), set it in front of herself, and pretended to fill it from the teapot. As she did so, she said, “I have to be careful with this tea pot. If I drop it, it could break.” After she ‘filled’ the teacup, the researcher set the teapot back on the tray, then placed the teacup in the center of the table. “Would you please hand that to my friend?” indicating the stuffed animal she served first. The researcher then took a second cup, of the other material, ‘filled’ it, and placed it in the center of the table, and asked the participant to give it to the other stuffed animal.

When in the plastic cup condition, the researcher said, “My friend is not very good at being careful, so she likes having a plastic cup.” When in the porcelain cup condition, the researcher said, “She likes the porcelain cup because she is good at being careful.”

The researcher asked the participant if she would like a plastic cup or a porcelain cup, ‘filled’ the chosen cup, and placed it at the center of the table, before ‘filling’ the remaining cup for herself. The participant and researcher then had a short tea party.

Results

Data from the six dependent variables were tested for normality and skewness using Kolmogorov-Smirnov, D’Agostino-Pearson, and Shapiro-Wilk, comparing the plastic and porcelain cup conditions. Peak velocity and time to peak velocity were found to have normal distribution; displacement and movement units were found to be skewed, and movement time had mixed results. Thus, Peak velocity was analyzed using a paired t-test while displacement, movement unit, movement time, and movement time to peak velocity data were analyzed using a Wilcoxon signed rank test.

As can be seen in Table 1, when comparing the two conditions, total reach time, movement units, peak velocity, and movement time to peak velocity were not found to be statistically significant with small effect sizes on displacement, peak velocity, and movement time to peak velocity. This similarity between the two conditions on these parameters can be seen in Figures 1-4. Figure 5 shows a noticeable difference in the displacement seen in the two conditions, and, while this difference achieved p=.0114, it was in the direction opposite of that predicted in the hypothesis, and, thus, cannot be considered statistically significant.

Data were also compared between conditions where the participants were asked to give the teacup to the stuffed animal to their right vs. to their left. There was a statistically significant difference in reach time (1.001 sec vs. 1.120 sec, p=.0414), but statistical significance was not found for any other dependent variable.

Discussion

The hypothesis under investigation in this study, that movement efficiency will be better in a low-risk occupationally-embedded condition than in a similar high-risk condition for healthy girls aged 7-9 years was not supported by the data collected. For four of the dependent variables, no statistically-significant difference was found between the two conditions, and, for the fifth, the higher-risk condition was more efficient. There are three possible explanations for these findings that merit discussion.

First, it may be that the girls in the study were simply incapable of perceiving risk and translating that perception into changes in their movements. It seems unlikely that they were unaware of the relative riskiness of the two conditions, as they were verbally reminded of the relative care needed with each of the teacups immediately before reaching for them, though this could have been the case. It seems more likely that their motor planning skills are not yet mature enough to translate that awareness to actual movements. This is in line with Traynor, Galea, & Pierrynowski (2012), who found such skills more in 9 and 10 year old children than younger ones. In their study, children ages 5-10 years and adults were instructed to move objects from a waist-height shelf to a higher shelf in time with a metronome, and measurements were taken of the muscle activation of the arm and shoulder girdle, as well as motion-capture data of the trunk, shoulder, arm, and hand. They found that 5-6 and 7-8 year olds had similar levels of smoothness across all segments, while 9-10 year olds' and adults' movements were smoother more proximal (i.e. at the shoulder) and became progressively less smooth at each section more distal, indicating 9-10 as a transition point in smoothness of motor planning. They characterize mature motor planning as "both stable and flexible" (p. 264), and that flexibility is particularly relevant for differentiating movement patterns between different situations, the area of investigation in the current study.

Second, it may be that the difference between the two conditions was too small to be detected in such a small sample size. While this is a possibility, there are several factors that make it seem unlikely. One factor may be that the effect sizes for displacement, peak velocity, and movement time to peak velocity were all small, indicating that, even with a larger sample, it is unlikely that meaningful differences would have been found. Another factor is that that the displacement data run in the opposite direction from the hypothesis. That is, the girls took a less-direct route to the plastic teacups than to the porcelain teacups. This could have been due to some other difference in the teacups. The handle shape of the two teacups is noticeably different, as can be seen in Figure 6, with the plastic cups' handle being more unusually-shaped. It is also possible that this result is a case of a Type I error, a possibility that is supported by the small effect size.

Third, and perhaps most likely, it may be that the occupational context for the experiment influenced the girls' motor performance more strongly than was anticipated. As can be seen in

Figure 7 and the description above, the movements were highly occupationally-embedded. However, the "tea party" occupation has inherent expectations of using dainty, careful movements, and the occupational form strongly re-enforced the scenario, with the participant, researcher, and even stuffed animals wearing "tea party" costume pieces, the table with embroidered tablecloth, and the interactions with the researcher being in keeping with the "tea party" scenario (e.g. asking if the participant would like milk or sugar in her tea). In purely subjective terms, the researcher collecting the data noted that the girls were consistently excited by and engaged during the tea party occupation, including generally electing to don the costume pieces and talking to their peers about it after their session. This possibility is in line with Wu, Trombly, Lin, and Tickle-Degnen's (1998) findings that both people with and without cerebrovascular accidents performed more efficient, direct, and pre-planned movements when reaching for a visible food chopper to chop a mushroom than when they reached for a chopper that they could not see because it was covered with cardboard. Volman, Wijnroks, and Vermeer (2002) similarly found faster, smoother, and better controlled movements when children with spastic hemiparesis reached for a functional light switch than a non-functional light switch or a marker. Also supporting the common intuition that the context of a movement matters is Holubar and Rice (2006) who studied the movements of healthy adult women in 4 conditions: reaching for their own and the researcher's mug at home and in a laboratory setting. Their findings were complicated, in that the setting did not seem to make a difference, though the mug did, and there was an interaction between the setting and the mug, and their discussion of the possible interactions between meanings of a familiar item in familiar and unfamiliar places and a movement with parts that were highly familiar (reaching for a coffee mug) and other parts that were contrived (setting it on a sticky note exactly 5 cm from the front of a shelf) demonstrate the complexity of inferring the meaning of an occupation for individuals, as well as the variety of conflicting influences these meanings may have on them.

The occupational form of tea party is one that was seemingly familiar to all the girls who participated in the study. This high level of meaning could easily have overwhelmed emerging motor planning skills to differentiate between more and less need for care or they may have "bought into" the pretend play strongly enough that they behaved as though all the tea cups were delicate. This points to several avenues of possible future research: perceived risk in less occupationally-embedded movements (e.g. reaching for a glass or plastic cup in a situation with fewer inherent cues for delicate movements), or even in cases where the occupational form runs counter to the perceived risk of an item (e.g. breakable and non-breakable items in situations with cues for rough handling).

There were a number of limitations to this study. The first was that the sample size was relatively small. It was also conducted with a sample group that had certain similarities beyond their age and gender: they were all living in the Midwestern United States and were largely recruited from girls participating in Girl Scout Brownie troupes. Their performance may not be reflective of girls living in other places or girls who do not share this organizational affiliation. It is also worth noting that the plastic and porcelain teacups, while they were of similar size, as can be seen in Figure 6, were not of equal weight, with the porcelain being heavier. As noted above, the handles of the cups were of different shapes, as well. Although there were elements of the occupational form that were quite naturalistic, the inclusion of the measurement equipment did introduce a degree of artificiality to the situation, and the girls were aware that their movements were being recorded. Although the situation seemed to be familiar and meaningful to the participants, it may have had meanings unintended by the researchers to some or all of the participants.

Future research in this area would be beneficial, particularly studies using a larger sample size, in different geographic areas, and with different recruitment. It would also be beneficial to take into consideration the performance elicited by the context beyond the variable element, and the strength of the influence it might have. Selecting a slightly older sample population, along with an occupational form that would be meaningful to that group, might also help to identify a transition age for adult-like motor changes based on perceived risk.

This study sought to investigate whether children were able to perceive risk and translate that perception into changes in motor plans. It has been established that adults have this ability and that children, especially older children, are able to perceive risk. Using motion analysis, we compared girls' movement when reaching for plastic and porcelain teacups, but did not find any statistically significant differences between their motions. This study has been a first step in determining the transition point for adult-like abilities to not only perceive risk, but to change motor plans in response to it. While the lack of statistically-significant findings does not lend itself to clear interpretation, it does point toward next steps to be taken in investigating the question: investigating slightly older children and using occupational forms that do not inherently evoke careful movements. It also indicates the need for researchers to take care in considering not only whether movements are rote or occupationally-embedded, but also the myriad cues present in any occupational form which can influence occupational performance.

References

About Occupational Therapy. Retrieved March 13, 2012, from http://www.aota.org/Consumers.aspx

Bakshi, R., Bhambhani, Y., & Madill, H. (1991). The effects of task preference on performance during purposeful and nonpurposeful activities. *American Journal of Occupational Therapy, 45*(10), 912-916.

Casey, B. J., Giedd, J. N., & Thomas, K. M. (2000). Structural and functional brain development and its relation to cognitive development. *Biological Psychology, 54*(1–3), 241-257. doi: 10.1016/s0301-0511(00)00058-2

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Psychology Press.

Ferrer-Chancy, M., Fugate, A. M., & Gouin, K. (2003). *How I grow: Months seven and eight* (Document No. FCS2220). Retrieved from University of Florida, Florida Cooperative Extension Service website: https://edis.ifas.ufl.edu/pdffiles/FY/FY63500.pdf

Fuller, H. M., Thomas, J. J., & Rice, M. S. (2006). Perceived risk: Effects on reaching and placing performance in persons with cerebrovascular accident. *American Journal of Occupational Therapy, 60*(4), 379-387. doi: 10.5014/ajot.60.4.379

Gillier, L. M., & Morrongiello, B. A. (1998). Age and gender differences in school-age children's appraisals of injury risk. *Journal of pediatric psychology, 23*(4), 229-238.

Gurfinkel, V. S., & Cordo, P. J. (1998). The scientific legacy of Nikolai Bernstein. In M. L. Latash (Ed.), *Progress in motor control: Bernstein's traditions in movement studies* (pp. 1-20). Champaign, IL: Human Kinetics Publishers.

Holubar, M. N., & Rice, M. S. (2006). The effects of contextual relevance and ownership on a reaching and placing task. *Australian Occupational Therapy Journal*, 35. doi: 10.1111/j.1440-1630.2006.00538.x

Lenroot, R. K., & Giedd, J. N. (2006). Brain development in children and adolescents: Insights from anatomical magnetic resonance imaging. *Neuroscience & Biobehavioral Reviews, 30*(6), 718-729. doi: 10.1016/j.neubiorev.2006.06.001

Luria, A. R. (1974). *The working brain: an introduction to neuropsychology*: Basic books.

Rice, M. S., & Thomas, J. J. (2000). Perceived risk as a constraint on occupational performance during hot and cold water pouring. *American Journal of Occupational Therapy*, *54*(5), 525-532. doi: 10.5014/ajot.54.5.525

Thomas, J. J., & Rice, M. S. (2002). Perceived risk and its effects on quality of movement in occupational performance of well-elderly individuals. *OTJR: Occupation, Participation and Health, 22*(3), 104-110.

Traynor, R., Galea, V., & Pierrynowski, M. R. (2012). The development of rhythm regularity, neuromuscular strategies, and movement smoothness during repetitive reaching in typically developing children. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology, 22*(2), 259-265.

Trombly, C., & Wu, C. (1999). Effect of rehabilitation tasks on organization of movement after stroke. *American Journal of Occupational Therapy, 53*(4), 333-344.

Volman, M., Wijnroks, A., & Vermeer, A. (2002). Effect of task context on reaching performance in children with spastic hemiparesis. *Clinical Rehabilitation, 16*(6), 684-692. doi: 10.1191/0269215502cr540oa

Wu, C., Trombly, C., & Lin, K. (1994). The relationship between occupational form and occupational performance: a kinematic perspective. *American Journal of Occupational Therapy, 48*(8), 679-687.

Wu, C., Trombly, C. A., Lin, K-c., & Tickle-Degnen, L. (1998) Effects of object affordances on reaching performance in persons with and without cerebrovascular accident. *American Journal of Occupational Therapy, 52*(6), 447-456.

Wu, C.-y., Wong, M.-k., Lin, K.-c., & Chen, H.-c. (2001). Effects of task goal and personal preference on seated reaching kinematics after stroke. *Stroke, 32*, 70-76. doi: 10.1161/01.STR.32.1.70

Table 1

Movement Differences when Reaching for Plastic and Porcelain Teacups

Variable	Porcelain Mean	Porcelain SD	Plastic Mean	Plastic SD	*t*-score	Signed Ranks	*p*- value	*d*
Movement time	1.06	0.21	1.06	0.25		-2	0.4896	-.01
Displacement(cm)	35.59	8.96	40.42	11.16		-141.0	0.0114	-.48
Movement Units	4.50	1.68	4.32	1.62		23	0.3088	.11
Peak Velocity	0.59	0.20	0.64	0.18	1.061		0.1504	-.22
Movement Time to Peak Velocity (s)	0.31	0.098	0.33	0.11		-21	0.3697	-.20

Figure 1. Comparison of Movement Time between Porcelain and Plastic Conditions

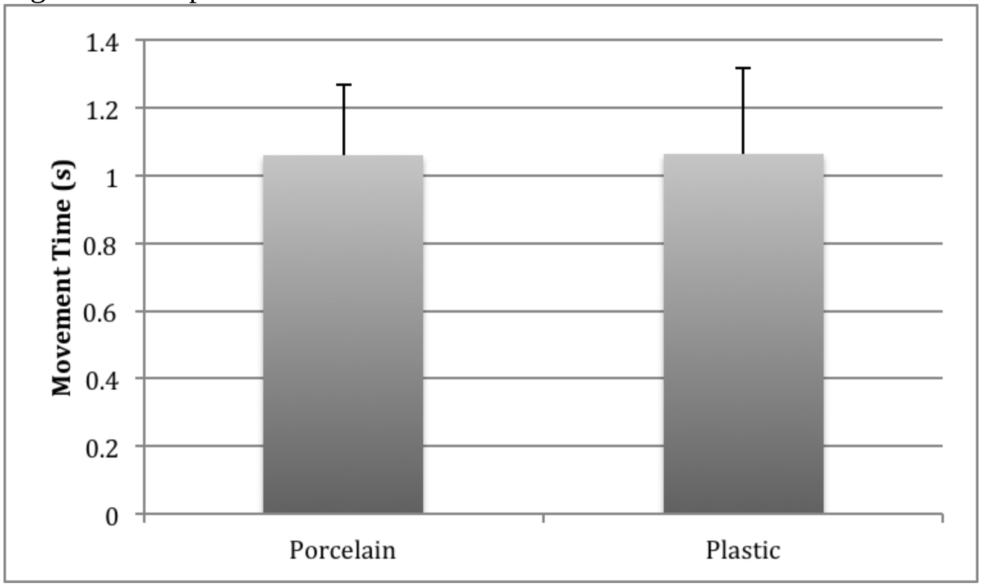

Figure 2. Comparison of Movement Units between Porcelain and Plastic Conditions

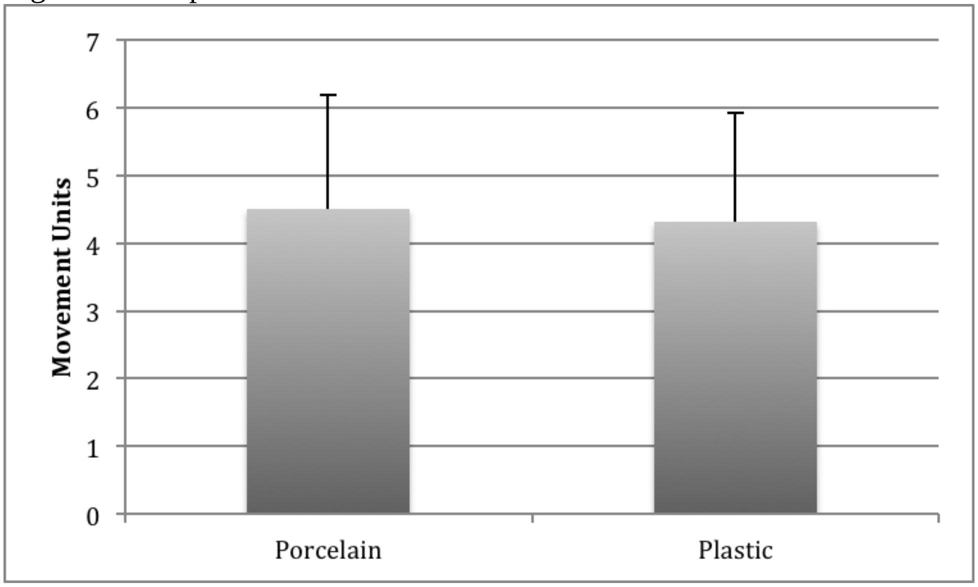

Figure 3. Comparison of Peak Velocity between Porcelain and Plastic Conditions

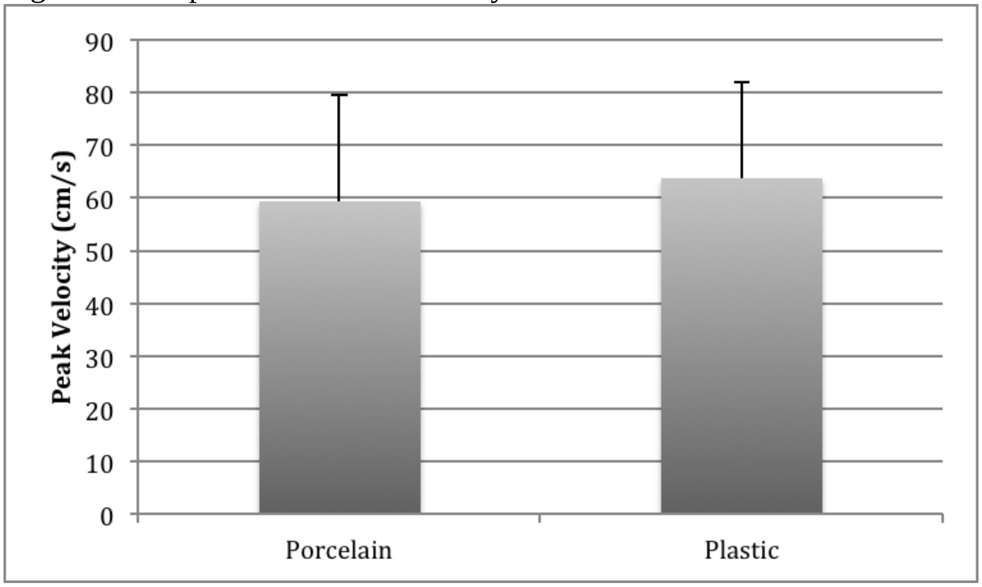

Figure 4. Comparison of Movement Time to Peak Velocity between Porcelain and Plastic Conditions

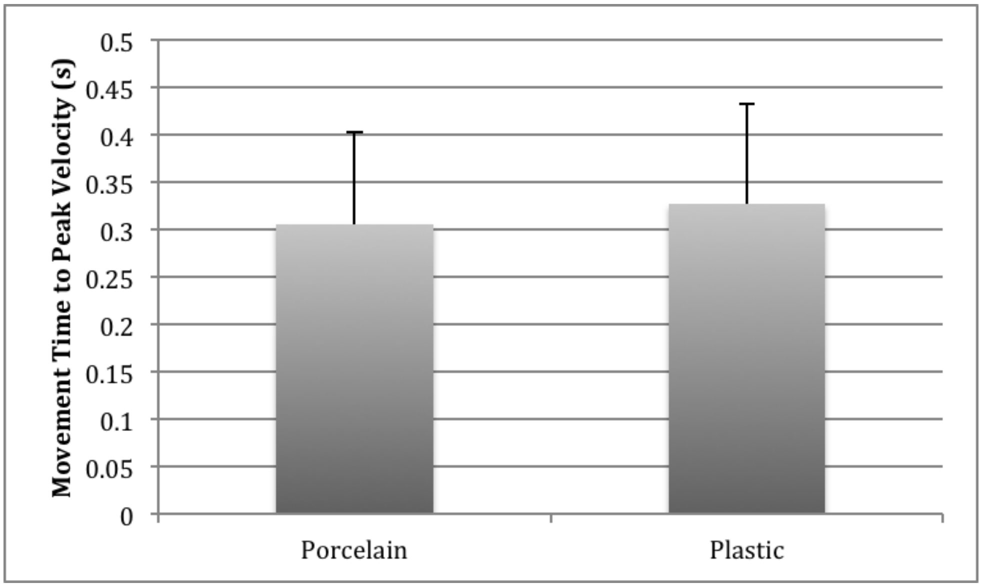

Figure 5. Comparison of Displacement between Porcelain and Plastic Conditions

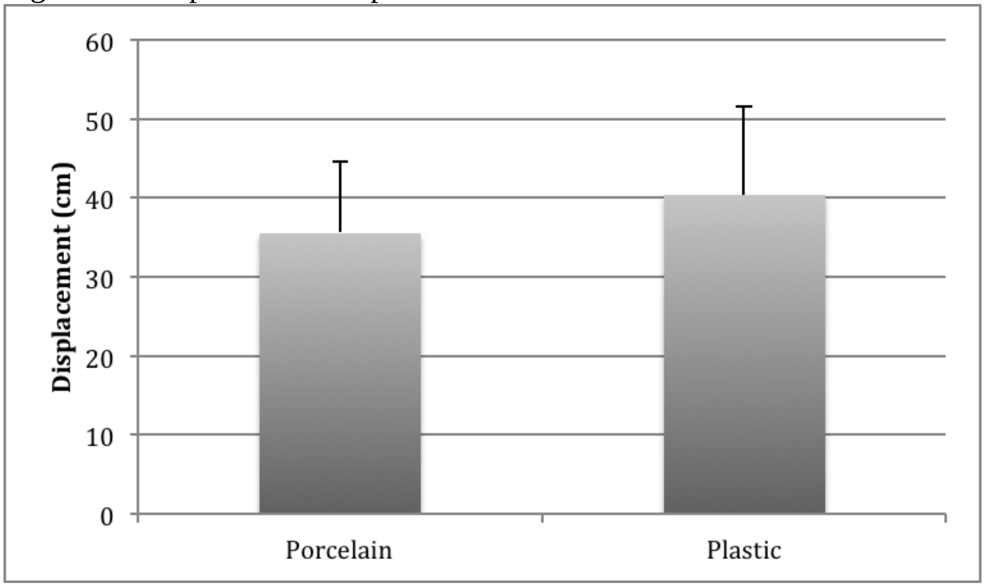

Figure 6. Plastic and Porcelain Teacups

Figure 7. Experimental Occupational

Form