Immediate versus Prolonged Visual Exposure and Object Relevancy in a Reaching and Placing Task

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Abstract: This study investigated whether prolonged exposure of objects with varying levels of meaning changes the quality of movement based upon the length of time the object is viewed. Fifty-nine male and female volunteers aged 18 to 45 years participated in this study that involved reaching for and placing a cup or a clay mass in an immediate or a prolonged exposure condition. It was hypothesized that better performance would occur when reaching for the cup than when reaching for the mold of clay. Additionally, there would be a difference in performance depending on whether participants experience the immediate or prolonged exposure of the objects. The results showed that movement time was significantly shorter and there were fewer movement units during the prolonged condition. There were also significant interactions between visual exposure and object relevancy for both percentage of movement time to peak velocity and average velocity. Conversely, there were no differences between the two objects for any of the dependent variables. This study suggests that if a person is allowed prolonged visual exposure to an object in a reaching and placing task his or her movement will be more efficient. This implies that occupational therapists should implement functional tasks and allow adequate time for the person to visually process occupational forms in order to facilitate enhanced quality of movement.

Introduction

A central concept in occupational therapy involves the use of meaningful objects in order to enhance occupational performance. Occupational therapists strive to choose the right occupations that appropriately challenge their clients' functional abilities in the most effective manner possible. A common strategy is to choose occupations in which the client finds meaning. Nelson defined meaning as "the person's entire interpretive process when encountering an occupational form, including perceptual, symbolic, and affective experience"[1]. Several studies have suggested that when a patient engages in an occupational form that has meaning and purpose, his or her motor performance tends to improve. [2-4]. Having a purpose can also influence the patient's performance. Nelson [1] defined purpose as "the experience of wanting an outcome from an anticipated occupational performance." Meaning and purpose can not be directly measured, however they can be inferred through observation and feedback from the patients themselves. The assumption that meaning and purpose are inferred is foundational to what the profession of occupational therapy is based upon. It is the responsibility of the occupational therapist to enhance meaning and purpose to the occupation. A person may perceive an object and though he or she may recognize the object, he or she may not ascribe meaning to the object. One of the assumptions in occupational therapy is that a person will perform better or with more enthusiasm if an object holds meaning. For example, a study by Kircher [5] recruited individuals who had expressed a prior interest in jumping rope. The participants involved were 26 women between the ages of 19 to 37 years. The task involved two exercises of jumping rope (purposeful activity) and jumping in place (nonpurposeful activity). The results showed that the participants' heart rates increased at a given rate of perceived exertion and were significantly higher in the jumping rope condition. The results supported the concept that in a non-meaningful occupation, the workload was perceived by the participants to be greater. A study by Hsieh, Nelson, Smith, and Peterson [6], investigated whether giving participants added-purpose occupations would elicit more exercise repetitions. Participants included 21 subjects with hemiplegia between the ages of 51-78 years. Each participant was to complete the three conditions of a dynamic standing balance exercise. This exercise involved bending down, reaching, standing up, and extending the arm. The three conditions included the added purpose, the imaging, and the control conditions. The task involved the target being placed 4m in front of the subject and with small balls placed on the ground near the unimpaired leg. The subjects picked the small balls up and tossed as many as they could for as long as they could to the target. The participants completed significantly more repetitions in the added-materials condition and in the imagery-based condition than in the rote exercise. These results support the concept that when occupational forms are occupationally embedded the performance that is elicited is of a higher level than when the occupational forms are not occupationally embedded. Ferguson and Trombly [2] investigated the effects of both added-purpose and meaningful occupation on motor learning. Participants were assigned to an added-purpose or a rote exercise condition. The task in the added-purpose condition required participants to practice three separate five-note patterns to produce a musical tune. The rote condition required the participants to practice the same patterns as in the added-purpose condition. The rote condition was meant only for learning purposes of a motor pattern without tone production. Participants in the rote exercise condition practiced the same three five-note patterns for the purpose of learning a motor pattern with production of a tune. Specifically the results were that the added-purpose condition demonstrated a significantly greater performance in motor learning. The results supported the concept that having an added-purpose can enhance performance in terms of permanent aspects, such as motor learning. Some studies suggest that the more contextually relevant the occupational forms are to the occupation, the better the occupational performance will be. For example, Ferguson and Rice [7] investigated whether practicing a complex self-care occupation in a contextually relevant environment would enhance the learning and transfer of skill. The participants included 56 college-aged women with a mean age of approximately 25 years. They were separated into either the contextually relevant group or the non-contextually relevant group. The task involved the contextually relevant group practicing tying a rope onto a pole using the style of knot as in the contextually relevant condition, which was practicing tying a necktie onto a mannequin. The results were that there was no difference in the rate of performance change during the acquisition phase between the contextually relevant and the non-contextually relevant groups. There was a significant difference in the rate of performance change among the three groups in movement time and movement units during the transfer phase. The results supported the concept that practicing an occupation in a contextually relevant environment would influence the learning and transfer of a motor skill.

Ma, Trombly, and Robinson-Podolski [8] investigated the effect of context on skill acquisition and transfer. The participants included 12 male and 28 female college students without disabilities. The task involved using chopsticks in either a natural or a simulated context. In the acquisition phase participants in the natural condition picked up pieces of cheese with metal chopsticks and placed the cheese in a dish. In the simulated condition, participants picked up small pieces of eraser. In the transfer phase the participants used wooden chopsticks and picked up shell-shaped pasta noodles to eat. The results were that the natural context elicited significantly greater success during the acquisition phase, as well as significantly greater success during the transfer phase compared to the participants in the simulated context. No differences were found in kinematic variables between the two contexts. The results supported the concept of using natural contexts to facilitate the outcome of motor skill learning.

Wu, Trombly and Lin [4] investigated whether reaching performance would show an enhanced quality of movement in a materials-based occupation (picking up a pencil and preparing to write their name) compared to both an imagery based occupation (imagining picking up a pencil and preparing to write their name) and in exercise (rote reaching pattern). The participants included 37 female college students. This study explored kinematic variables of reaction time, movement time, number of movement units, and amplitude of peak velocity and percentage of movement time at which peak velocity occurred. The materials based condition involved having the participants pick up a pencil from a pencil holder and prepare to write their name. In the imagery-based occupation they picked up the pencil from a point in space and in the exercise condition they performed a movement of reaching forward. The results were that the materials-based occupation elicited an enhanced quality of movement performance as compared to the imagery-based and exercise conditions. The results supported the concept that material-based occupations might be useful in eliciting an enhanced quality of reaching movement. Gasser-Wieland and Rice [9], investigated the effects of enhanced occupational embeddedness on upper extremity movement dynamics. Participants included 17 survivors of cerebral vascular accident (CVA). The experiment involved two conditions including the occupational embedded (labeled soup cans) and nonoccupationally embedded (clay masses) conditions. Participants were to move their assigned objects (either the soup cans or clay masses) from a kitchen counter to the cabinet with each limb. The results were that the occupational embedded condition demonstrated significantly fewer movement units and smaller movement times. The results supported the theory that greater occupational embeddedness can encourage enhanced motor performance.

Rice, Alaimo, and Cook [3], investigated the movement dynamics during a grasping and placing task with objects having varying levels of occupational embeddedness. Participants included 39 females between the ages of 22 and 52 years. The task involved three conditions including the occupationally embedded, limited occupationally embedded, and the nonoccupatoinally embedded conditions. In this repeated measures design, the occupational embedded condition grasped labeled soup cans from a countertop and placed them onto a cupboard shelf. The limited occupationally embedded condition and the nonocccupationally embedded condition followed the same pattern using unlabelled soup can and modeling clay respectively. The results were that significance was found between the limited occupationally embedded group and the nonoccupationally embedded group and between the occupationally embedded group and the nonoccuationally embedded group. The results supported the concept that relevant occupational forms are important for enhancing the quality of movement. The concept of meaning can be discussed in a temporal domain. Studies have shown the immediate effects of meaning, but no study has examined the effect of exposure time to an occupational form upon occupational performance. The cognitive task of "thinking" takes processing time in the central nervous system. The research reviewed above has shown that meaningful occupational forms can either influence occupational performance when an object is immediately exposed. What needs to be investigated is if a prolonged exposure of an object is going to change the occupational performance outcome or remain the same. The purpose of this study was to examine the effect of object relevancy upon motor performance after an immediate or prolonged exposure. The independent variables include object relevancy and relative length of visual exposure. To operationalize this, the following hypotheses were formed. The first hypothesis for this study is that the participants will perform better when reaching for the cup than when reaching for the mold of clay. The second hypothesis is there will be a difference in performance depending on whether participants experience the immediate or prolonged exposure of the objects. The third hypothesis is there will be an interaction between the factors of object relevancy and visual exposure. Dependent variables include: movement time, displacement, peak velocity, percentage of movement time to peak velocity, movement units and average velocity.

Materials and Methods

Participants

Participants included 59 healthy male and female volunteers aged 18-45 years who were recruited from the mid-west portion of the United States. Participant recruitment occurred through posters and through word-of-mouth from November 2004 through January 2005.

Apparatus

Kinematic data were collected at 120 Hz using a four-camera Qualysis ProReflex 3-dimensional system. This system records the 3-dementional spatial coordinates of reflective markers that are affixed to bony landmarks on the participant's upper extremity and upper body.

Randomization

This is a two-factor experiment with repeated measures on one factor. As such, this design requires 2 levels of randomization, one to determine which non-repeated factor to assign participants, and another to determine the order of the repeated factor to assign. The repeated factor was nested within the non-repeated factor [10]. The non-repeated factor was visual exposure (opaque or transparent door) and the repeated factor was object relevancy (cup or clay mass). Figure 1 illustrates the cup and clay mass. Using a customized computer random-number generator software program, two levels of randomization were generated. For the non-repeated factor, participants were randomly assigned to either the opaque door experiment or the transparent door condition. Once assigned to a condition, participants were randomly assigned to one of the possible order groups (e.g. cup-clay or clay-cup) for the random factor of object relevancy. Additionally, within each level of randomization, groups of participants were randomly assigned to randomizing 'blocks." Specifically for the repeated factor there were 3 blocks of 8 participants, 5 blocks of 4 participants and 8 blocks of 2 participants (for a total of 60 potential participants). This second level of randomization was done twice so that each level of the non-repeated factor ended up with 30 randomized participants. In addition, the order in which the blocks present themselves were randomly assigned using a customized computer random-number generator software program. The data collection investigator entered the participant's subject number in a computer program that date and time stamped the occurrence of accessing the participant's subject number. In doing so, the investigator was not able to anticipate the participant's group assignment prior to that participant's data collection session.

Figure 1: *Cup and clay mass*

Procedures

This study was approved by the Medical University of Ohio's Institutional Review Board; IRB#104768. The data collection site consisted of a room that was approximately 40 feet by 30 feet. At one end of the room an object (either a cup or a mass of clay wrapped in aluminum foil was placed upon a shelf that was attached to table. The object (either the cup or the clay) sat on the shelf, but was behind a hinged door. The door was hinged on the bottom. The door had a 'knob' that was mounted on the right side edge of the door. When the door opened, the shelf and the object were visually unobstructed for the participant. There was a micro switch placed upon the bottom so that when the door was opened the micro switch engaged and sent a signal to the computer. This standardized the starting location for the reach portion of the movement. The shelf had a switch upon which the cup and the mass of clay wrapped in aluminum foil rested. This switch signaled the computer when the participant touched the object. The target for where the object was placed

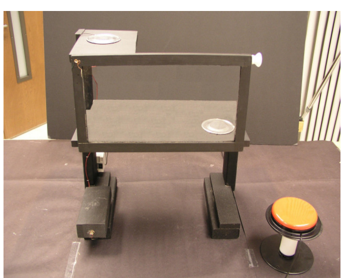

Figure 2. Immediate

by the participant consisted of a second switch that, when touched by the object, signaled the computer indicating the time at which the object touched the target. Therefore each portion of the upper extremity movement was 'marked,' for instance; the reach portion consisted from when the door was completely opened to when the hand touched the object. The transport portion of the motion was from when the object was lifted from the shelf to when the object was placed upon the second target. In addition there was a "starting" switch that was engaged when the participant lifted his or her hand that triggered the initiation of data collection. Figure 2 illustrates the immediate condition setup. Once informed consent was obtained, the data collection investigator entered the participant's subject number into the software program that indicated the order of presentation of conditions for the participant. Informed consent occurred in a room adjacent to where the data collection occurred. Reflective markers were placed on the participant's acromion process, mid humerus, elbow, wrist, metacarpal of the index finger, and the finger nails of the thumb and index finger of the right limb. The informed consent room had a shelf display nearly identical to the one located in the data collection room. The display unit had a translucent door. A translucent door was chosen so that the practice unit was equally similar/dissimilar to the opaque and transparent doors of the experimental units. The following instructions were read to the participant. "In the other room you will see a display very similar to this one before you. One difference is that inside the display there will be an object located on the shelf. I would like you to walk into the other room and place your right hand on the start/stop place. Then when I say "go," with your right hand I would like you to open the door so that the door is opened the whole way like this (the data collection investigator demonstrates). Then I would like you to move the object from the lower shelf and set it on the second shelf. Once you set the object down, you can place your hand back on the start/stop place. When you move the object, move at a rate that is most comfortable to you. Now I would like you to practice opening this door." (After the participant successfully open the practice door the data collection investigator asked the following.) "Do you have any questions?" (If the participant had any questions, particularly procedural-type questions, the data collection investigator would answer them.). The investigator then asked the participant to stand in the staging area with his or her back to the apparatus and instructed the client to wait there until the investigator tested the EMG wires. The participant was then instructed to turn around, step up to the black "X" on floor, place his or her hand on the start/stop button and wait for the investigator to say "begin" at which time, the participant began the trial. When the trial was completed, the investigator readied the experimental unit for the next trial by returning the appropriate object to the shelf and re-closing the door. After trial 3 was completed the participant was asked to turn around so that he or she was unable to view the apparatus. The investigator then switched the object and readied the experimental unit for the next trail. Once the unit was readied, the participant was asked to turn back around and place his or her hand on the start/stop button and wait for the investigator to say "begin." Each participant performed 3 trials for each condition so that each participant performed 6 trials in all.

Statistical Analyses : A 2x2 (visual exposure x object relevancy) analysis of variance (ANOVA) with repeated measure on the second factor was performed on each of the dependent variables. Trials 1 and 4 were included in the analysis as each trail represented the first exposure to each object.

Results

Reach Phase: For the reach phase, the first hypothesis was not supported. There were no significant differences between the two objects for any of the dependent variables (See Table 1). The second hypothesis was supported in that movement time during the prolonged condition was significantly shorter; in addition, the prolonged condition had fewer movement units, (See Tables 1 & 2). The third hypothesis was supported in that there were significant visual exposures by object interaction for percentage of MT to peak velocity and for average absolute velocity. See Table 2 for the reach phase descriptive statistics. See Figures 3 and 4 for the respective interaction plots.

Table 1: *Analysis of variance table for the reach phase for the dependent variables of movement time, displacement, peak velocity, percentage of movement time to peak velocity, movement units and average absolute velocity.*

Variable Source	dF	Sums of Squares	Mean Square	F	*p*
Movement Time					
Within					
Object	1	.005	.005	.098	.755
Object x VE	1	.092	.092	1.807	.184
Error	57	2.902	.051		
Between					
VE	1	.462	.462	5.78	.019
Error	57	4.557	.08		
Displacement					
Within					
Object	1	8834.270	8834.270	1.013	.318
Object x VE	1	1147.603	1147.603	.132	.718
Error	57	497025.313	8719.742		
Betweenv					
VE	1	367.642	367.642	.025	.875
Error	57	844467.511	14815.219		
Peak Velocity					
Within					
Object	1	252161.618	252161.618	3.022	.088
Object x VE	1	8158.587	8158.857	.098	.756
Error	57	4755666.091	83432.738		
Between					
VE	1	386310.312	386310.312	1.732	.193
Error	57	12710786.101	222996.247		
Percentage of MT to Peak Velocity					
Within					
Object	1	.045	.045	1.907	.173
Object x VE	1	.145	.145	6.189	.016

Error	57	1.333	.023		
Between					
VE	1	.082	.082	1.025	.316
Error	57	4.540	.080		

Movement Units					
Within					
Object	1	11.552	11.552	3.248	.077
Object x VE	1	.162	.162	.046	.832
Error	57	202.736	3.557		
Between					
VE	1	20.508	20.508	4.131	.047
Error	57	282.966	4.964		
Average Absolute Velocity					
Within					
Object	1	477646.791	477646.791	2.336	.132
Object x VE	1	1091710.776	1091710.776	5.339	.024
Error	57	11654216.463	204459.938		
Between					
VE	1	359138.498	359138.498	.766	.385
Error	57	2674117.212	469142.232		

Note: 59 with 30 participants for the immediate group and 29 for the prolonged group, VE = visual exposure

Table 2:*Reach phase means and standard deviations of movement time, displacement, peak velocity, percentage of movement time to peak velocity, movement units, and average velocity*

				Prolonged			
Cup		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	0.57	322.04	1269.87	0.56	2.21	669.00
	Sdev	0.24	135.63	506.36	0.26	1.78	795.45
Clay		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	0.64	310.97	1194.03	0.45	2.76	349.34
	Sdev	0.21	80.85	381.37	0.25	1.81	480.01
				Immediate			
Cup		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	0.75	331.80	1172.05	0.55	2.97	366.25
	Sdev	0.30	100.44	353.96	0.19	2.13	477.40
Clay		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	0.71	308.26	1062.95	0.58	3.67	431.38
	Sdev	0.26	109.99	298.35	0.21	2.45	512.52

Note: MT = Movement Time, Disp = displacement, PK Vel = Peak Velocity, MU = Movement Units, Ave Vel = Average Velocity

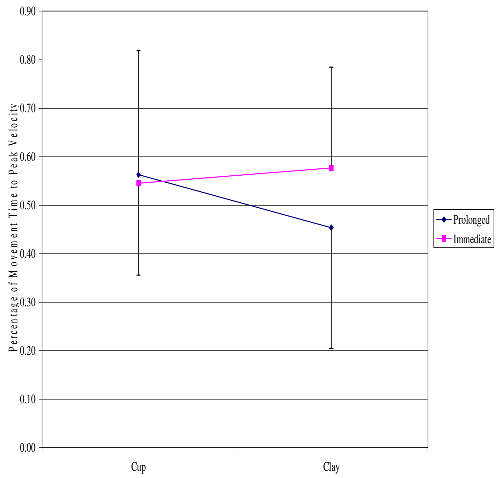

Figure 3: Reach phase percentage of movement time to peak velocity interaction for visual exposure and object relevancy.

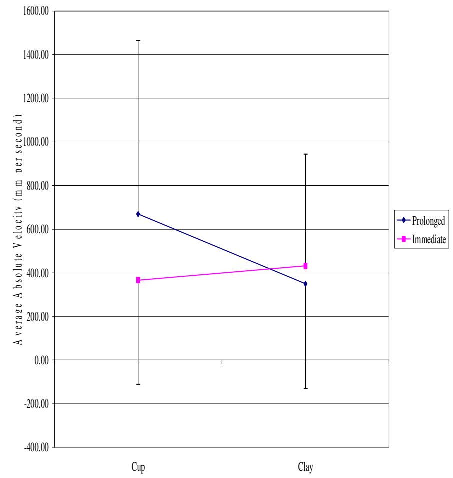

Figure 4: Reach phase average absolute velocity interaction for visual exposure and object relevancy.

Transport Phase:

For the transport phase, the first hypothesis was supported in that there were significantly fewer movement units during the conditions with the Cup. Hypotheses 2 and 3 were not supported in that there were no significant differences between the immediate and prolonged conditions, nor were there any significant visual exposure by object interactions. See Table 3 for the transport phase descriptive statistics. See Table 4 for the transport phase ANOVA Table.

Table 3. *Transport phase means and standard deviations of movement time, displacement, peak velocity, percentage of movement time to peak velocity, movement*

				Prolonged			
Cup		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	1.28	458.85	886.39	0.36	5.34	82.15
	Sdev	0.30	122.49	267.84	0.14	3.83	89.89
Clay		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	1.28	461.61	882.95	0.42	6.17	101.03
	Sdev	0.32	166.32	332.29	0.15	4.28	103.20
				Immediate			
Cup		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	1.29	393.55	792.82	0.38	7.10	96.46
	Sdev	0.36	115.63	199.77	0.13	5.62	83.24
Clay		MT(s)	Disp(mm)	Pk Vel(mm/s)	% MT to Pk Vel	MU	Ave Vel(mm/s)
	Mean	1.46	429.03	789.53	0.42	7.70	91.64
	Sdev	0.41	130.87	211.82	0.14	5.28	80.93

Note: MT = Movement Time, Disp = displacement, PK Vel = Peak Velocity, MU = Movement

Table 4:*Analysis of variance table for the transport phase for the dependent variables of movement time, displacement, peak velocity, percentage of movement time to peak velocity, movement units and average absolute velocity.*

Variable Source	dF	Sums of Squares	Mean Square	F	*p*
Movement Time					
Within					
Object	1	.211	.211	2.797	.100
Object x VE	1	.214	.214	2.839	.097
Error	57	4.297	.075		
Between					
VE	1	.241	.241	1.393	.243
Error	57	9.881	.173		
Displacement					
Within					
Object	1	10778.986	10778.986	.943	.336
Object x VE	1	7890.516	7890.516	.690	.410
Error	57	651752.426	11434.253		
Between					
VE	1	70645.603	70645.603	2.821	.099
Error	57	1427336.169	25040.985		
Peak Velocity					
Within					
Object	1	333.560	333.560	.011	.917
Object x VE	1	.169	.169	.000	.998
Error	57	1739628.098	30519.791		
Between					
VE	1	257777.438	257777.438	2.525	.118
Error	57	5819212.768	102091.452		
Percentage of MT to Peak Velocity					
Within					
Object	1	.078	.078	4.180	.046
Object x VE	1	.004	.004	.194	.661
Error	57	1.070	.019		
Between					
VE	1	.004	.004	.174	.678
Error	57	1.200	.021		
Movement Units					
Within					
Object	1	15.026	15.026	.915	.343
Object x VE	1	.382	.382	.023	.879
Error	57	953.669	16.415		
Between					
VE	1	79.454	79.454	2.645	.109
Error	57	1712.021	30.035		
Average Absolute Velocity					

Within					
Object	1	1384.556	1384.556	.736	.395
Object x VE	1	4017.614	4017.614	2.134	.150
Error	57	107289.085	1882.265		
Between					
VE	1	154.013	154.013	.011	.917
Error	57	808032.358	14176.006		

Note: 59 with 30 participants for the immediate group and 29 for the prolonged group, VE = visual exposure

There were no statistically significant order effects, nor did the data significantly deviate from a Gaussian population distribution.

Discussion

The concept of meaning can be discussed in a temporal domain. Studies have shown the immediate effects of meaning, but no study has examined the effect of exposure time to an occupational form upon occupational performance. The cognitive task of "thinking" takes processing time within the central nervous system. Research has shown that meaningful occupational forms can influence occupational performance when an object is immediately exposed. This study investigated if a prolonged exposure of an object along with object relevancy influences quality of movement. The first hypothesis investigated if the participants would perform better when reaching for the cup than when reaching for the mold of clay. The reaching phase did not show any significant differences between the cup condition and the clay condition for any of the dependent variables. This is in contrast to several other studies that investigated object relevancy. For example, Rice, Alaimo, and Cook [3] and Gasser-Wieland and Rice [9]found that the object with greater relevancy (i.e. can) elicited a more efficient motion than the object with less relevancy (i.e. mass of clay). Interestingly, the transport phase showed a less efficient movement pattern during the clay condition in terms of movement time to peak velocity in that the percentage in the clay condition was greater compared to the cup condition. However, the percentages of both conditions were within the first half of the movement. This indicates that in both conditions, the majority of movement time occurred after the peak velocity occurred. This coupled with the statistically non-significant difference of the other dependent variables may indicate that a Type I error occuredoccurred. This supports the general findings of the Rice, et al. [3]and Gasser-Wieland and Rice [9]studies. Both of these studies found that the condition with a higher object relevancy (can) opposed to the condition with a lower object relevancy (clay) was more efficient. Additionally, although not statically different, there was a shorter movement time, fewer movement units and a smaller total displacement in the occupational embedded condition; all of which demonstrate a trend towards greater movement efficiency. The second hypothesis looked for a difference in performance depending on whether participants experienced the immediate or prolonged exposure of the objects. This hypothesis was supported in that movement time was significantly shorter and there were fewer movement units during the prolonged condition. When participants had increased time to observe the objects before reaching for them, they took less time and used fewer movements units during the reach phase. This suggests that participants were planning their motor performance during the prolonged condition and therefore they were able to develop a more efficient motor plan which manifested itself during the actual reach phase. The time allowed for them to view the object may have been long enough to allow them to ascribe a level of meaning and purpose to the occupational form influencing the participant just enough to effect his or her movement. Interestingly, this effect did not carry over to the transport phase in that there were no differences regarding the amount of visual exposure. It may be that the influence of time may be limited to the initial reach portion of the movement. After the object has been retrieved, it is possible that separate executable movement strategies are employed for the two separate portions of the motion; that is the reach portion and the transport portion. It is possible that when given time to visually inspect an object that the initial motor plan is developed (i.e. more preplanned) than the motor plan for the transport phase. It is possible that the goal of each specific sub-movement may also influence the motor plan development. For instance, the goal of the reach portion is specifically different in that the hand is brought toward the object with the goal to grasp the object whereas the goal of the transport phase was to move the object from one place to another. These are two distinctly different goals with both having their own associated stereotypic kinetics and kinematics. It may be that the goal of grasping requires greater specificity, (e.g., requiring finger aperture, hand orientation) and therefore, when given the opportunity from having an extended amount of time to view the object, the participants' motor system develops a more refined efficient executable motor program. The third hypothesis investigated whether an interaction between the factors of object relevancy and visual exposure occurred. The third hypothesis was supported in that there were significant interactions between visual exposure and object for percentage of movement time to peak velocity and for an average velocity during the reach phase. When considering these interactions, the change in performance was greater when reaching for the objects in the prolonged condition compared to the immediate condition. Specifically, when reaching for the clay, peak velocity occurred later and the average velocity was reduced suggesting that greater cognitive effort was employed compared to when reaching for the cup. The participants may have needed the extended time to ascribe meaning to an object that was unfamiliar to them (e.g. mass of clay) opposed to the cup, which arguably, the participants had greater familiarity. Wu, Trombly, and Lin [4] found similar results in that the movement elicited while reaching for the a pen was more efficient than when performing the rote exercise reaching pattern. Wu et al. [4] suggested that a material-based occupation brought about a more pre-programmed movement, better performance, and more economical performance than an imagery-based occupation or exercise. Limitations of this study included the presence of "lab" equipment which could have adversely affected the meaning ascribed to the two objects. A more natural setting or apparatus, such as kitchen shelf would present more ascribed meaning. The numerous wires attached to the participant's arms may have limited his or her natural movement for fear of pulling them. Another limitation is that some data had to be discarded because the

participant did not follow the correct procedure. This research suggests that the prolonged condition enhanced the quality of a
reaching and placing task with faster and more efficient movement. Allowing the participant to view the object for a relatively prolonged period of time permitted them to adequately view and visually perceive the object. Occupational therapists can apply this concept to clinical situations. Manipulating the occupational forms for the patient to allow more time to view and process the occupational form may facilitate a better quality movement. For example, putting away groceries from clear bags to a cabinet with transparent doors may aid in a better quality of movement compared to a rote exercise that simulates the same type of movement pattern. Specifically, it may be possible to facilitate a more efficient and effective movement by ensuring a relatively prolonged visual exposure time while incorporating an object with relative familiarity. This implies that occupational therapists should implement functional tasks using meaningful objects and to allow adequate time for the person to visually process and complete the occupation in therapy sessions. Future research needs to examine visual exposure while performing common movements or occupations of daily living, such as self-care. Tasks such as brushing your teeth, combing your hair, and bathing are examples of what people complete on a daily basis. When the object is more familiar coupled with adequate time for visually perceiving the object, greater movement efficiency can be anticipated. An example would be to study the movement dynamics of a patient receiving home care rehabilitation. For instance, reaching for items in a medicine cabinet with a translucent door may elicit a more efficient movement then if the door were opaque.

Conclusion

The results of this study suggest that providing increased time for viewing relatively familiar objects to be reached for can result in greater movement efficiency. This is particularly true when the participant reached for an object that has inherent meaning, supporting past results that have found that greater occupational embeddedness can promote enhanced motor performance. This study suggests that the more naturalistic the occupation and the more relevant the occupational form are as well as allowing the adequate visual exposure will enhance the patient's performance at the task. It is important for practitioners to be aware of the importance of a naturalistic setting as well as adequate visual exposure of a motor task to ensure the optimal performance. Furthermore, additional research needs to be done to further determine the effect of relevancy and prolonged exposure.

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