EVALUATING MUSCLE ELECTROMYOGRAPHY (EMG) IN FEMALES ACROSS THE ANTHROPOMETRIC SPECTRUM FOR THREE COMPUTER INPUT DEVICES

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Abstract

Computers are ubiquitous in daily life; they have become a required tool for students and many professions. Computer input devices such as mice and keyboards are known risk factors for upper extremity muscle skeletal disorders, and previous research has suggested that some device designs are safer than others, and women experience a higher rate of injury which may be due to their smaller anthropometry. This study used electromyography to examine the relationship among three different computer pointing devices in women across an anthropometric spectrum. In addition, the devices were tested in both the normal location to the right of the keyboard and at the center. Subjects were asked qualitative questions (yes/no and likert) about their experiences with the devices. The results showed a significant difference in measured and reported outcomes due to the different devices, but location and anthropometric measurements did not have a significant effect.

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INPUT DEVICES

Introduction

Computer Input Devices

Computers are ubiquitous in daily life; they have become a required tool for students and many professions, and many people spend the majority of their day working on some form of a computer. Unfortunately, the required input device peripherals such as keyboards and mice were designed to fit the task of inputting information to a computer and not a human user's hands, and the mouse's efficient design has changed little since it was first introduced in the 1960's (Edwards, 2008; Engelbart, 1970). While the typical computer mouse is efficient and easy to use, it was never intended to be used for hours at a time. Computing has changed drastically since the 1960, and the switch to digital interfaces in fields such as drafting, design, and photo editing means that people are ever increasing their time spent using mice. Using a mouse for long periods of precise work can strain the hand, arm, and shoulder, which accumulates over time.

The human factors/ergonomics community first recognized computer mice as a potential risk for musculoskeletal disorders in the 1990's. The first study of computer mice found non-neutral postures and warned that more investigation and more ergonomic designs were necessary (Karlqvist, Hagberg, & Selin, 1994). In 1994, Liberty Mutual Group analyzed worker's compensation claims from 1986 to 1993 and discovered an increasing rate of reported mouse-related injury claims and computer-related injury claims overall (Fogleman & Brogmus, 1995).

They noted that mouse-related claims involved more body parts (hand, wrist, upperarm, lower arm) than other computer-related claims, and that females experienced a disproportionate number and cost for all upper limb cumulative trauma disorders. The authors speculated that the cumulative nature of these injuries explains some of the increase over time and that computer related injuries would soon become a larger problem in the U.S. work force.

Twenty years later, in its Workplace Safety index, Liberty Mutual ranked the top workplace injuries from the U.S. Bureau of Labor Statistics and found that repetitive motions including micro-tasks accounted for $1.84 billion in direct costs, 3.1% of overall costs and the 9th highest overall (Liberty Mutual Research Institute for Safety, 2015). In 2007, it was estimated that occupational injuries and illnesses accounted for $67 billion in direct medical costs and $183 billion, and worker's compensation only paid 25% of these costs (Leigh, 2011). The costs of injured workers and their lost wages are high for private insurance providers, families, and society (Leigh & Marcin, 2012). Moreover, these injury rates will continue to increase if people keep using computer input devices from a young age for many hours a day (Straker, et al., 2008). Little research has been done to explore the amount of exposure before injury, or how increased computer use in k-16 education; however, initial research shows a need for intervention before students enter the workforce (Noack-Cooper, Sommerich, & Mirka, 2009).

Computer-Related Injuries

There are many terminologies to describe the class of computer-related injuries.

The Occupational Health and Safety Administration (OSHA) classifies them as

musculoskeletal disorders (Occupational Safety and Health Definitions, 2012)

which includes "injuries or disorders of the muscles, nerves, tendons, joints,

cartilage, and disorders of the nerves, tendons, muscles and supporting

structures of the upper and lower limbs, neck, and lower back that are caused,

precipitated or exacerbated by sudden exertion or prolonged exposure to

physical factors such as repetition, force, vibration, or awkward posture" (CDC,

2015) . Injuries caused by computer use are developed over time due to

repetitive micro-tasks and unnatural postures that stress and strain upper body

nerves, muscles, tendons, ligaments, and fascia (Wickens, Lee, Liu, & Gordon

Becker, 2004). Other terminologies for these injuries include cumulative trauma

disorder (CTD), cumulative trauma disorder of the upper extremities (CTDUE),

repetitive strain injury (RSI), upper extremity musculoskeletal disorder (UEMSD),

neck/shoulder musculoskeletal disorder (NSMSD), and work-related

musculoskeletal disorder (WMSD). These umbrella terminologies are used to

describe musculoskeletal conditions such as:

- Carpal tunnel syndrome (CTS) : compression of the median nerve

- Tenosynovitis: swelling the fluid surrounding tendons

- Tendonitis: swelling of tendons

- Neuropathy: pain, numbness, and tingling due to nerve injury or illness

- Thoracic outlet syndrome: compressed nerves and blood vessels in the thoracic outlet between the ribs and collarbone

Alternative Pointing Devices

Though the standard mouse persists, various alternative pointing devices have been created to improve upon the standard mouse. These include the vertical mouse, trackpoint (on a laptop keyboard), trackpad, trackball, and rollermouse (Figure 1). The study described in this paper used a standard mouse, a trackpad, and a rollermouse. Trackpads or touchpads are flat surfaces with tactile sensors that translate the user's finger motion and position to control a computer interface pointer. Present on almost all new laptop and notebook computers, trackpads are increasingly becoming the most common computer input device. Larger, external trackpads are available for use with desktop computers. The Logitech T650 Touchpad shown in Figure 1 has a continuous flat surface with no buttons. It features one finger tap left clicks (bottom right corner for right click), 2 finger vertical and horizontal scrolling, pinch to zoom, and 3 or 4 finger Windows 8 shortcuts. The Contour Design RollerMouse® Free2 (Figure 2) is a novel design that rests in front of a keyboard. It features a rollerbar that can roll up, down, and side to side to move the cursor, as well as "click" by being pushed down. It also has left click, right click, double click buttons, copy and paste buttons, and a scroll wheel. The rollermouse can be used by either or both hands.

Figure 1: Examples of mouse alternatives. From left: vertical mouse, trackpoint, trackpad, trackball, rollermouse.

Figure 2: Contour Design Rollermouse ® A: rollerbar for pointing, clicking, and dragging using any combination of fingers. B: left click. C: right click. D: scroll. E: double click

Study Design Overview

This study used skin electromyography to measure muscle activity among three different computer pointing devices (mouse, trackpad, Contour rollerbar) in women across an anthropometric scale. In addition, the mouse and trackpad were tested in both the typical location to the right of the keyboard and at the center in front of the keyboard. Muscle activity was recorded and analyzed for the extensor carpi radialis (ECR) and trapezius (TRAP) muscles during a computer activity. Subjects were also asked subjective questions about their familiarity, comfort, and experience with each device. The results of this study will add to the literature about muscle activity during pointing tasks and provide insight into the higher rate of MSDs observed in women.

Survey of Literature

Computer-related Musculoskeletal Disorders

Computer input devices such as mice and keyboards are known risk factors for upper extremity musculoskeletal disorders (UEMSDs), and while keyboard contributions have been well studied, fewer studies of the relationship between injury and mousing devices have been done (Cook, Burgess-Limerick, & Chang, 2000). The growing use of graphical user interfaces in many fields has made pointing devices, especially mice, the primary input device in many professions (Fogleman & Brogmus, 1995; Atkinson, Woods, Haslam, & Buckle, 2004; Bystrom, Hansson, Rylander, Ohlsson, Kallrot, & Skerfving, 2002).

A 2007 review concluded that there was "moderate evidence… for a positive association between the duration of mouse use and hand arm symptoms…which were in general stronger...for mouse use" (IJmker, Huysmans, Blatter, van der Beek, van Mechelen, & Bongers, 2007, p. 211). The non-neutral postures required for pointing and dragging tasks can cause high nerve pressures in the wrist, especially among the carpal bones (Karlqvist, Hagberg, & Selin, 1994; Keir, Bach, & Rempel, 1999; Fagarasanu & Kumar, 2003).
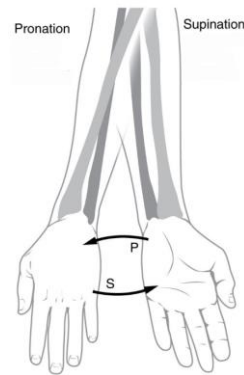
Figure 3: Pronation and Supination for the forearm. Pronation turns the palm down towards the ground and supination turns the palm up towards the ceiling. By Connexions (http://cnx.org) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons
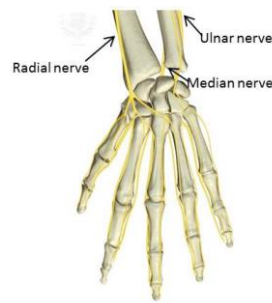
Figure 4: Nerves of the hand. The radial nerve runs along the inside of the pronated arm on the thumb side. The median nerve runs in between bones and is commonly compressed in carpal tunnel syndrome. The ulnar nerve runs along the outside of the pronated arm to the smallest digit. The nerves of the hand. *Illustration.* Encyclopædia Britannica ImageQuest. *Web. 27 Jun 2015.*

Wrist extension, forearm pronation and supination (Figure 3), and radial and ulnar deviation cause the highest pressures (Figure 4), and all of these postures except supination are required by standard mice (Werner, Armstrong, & Aylard, 1997). Cook, Burgess-Limerick, & Chang (2000) found that maintaining pressure while clicking and dragging increases intracarpal canal pressures and a relationship between mouse use and neck pain symptoms. These elevated pressures are related to cumulative trauma disorders (Fagarasanu & Kumar, 2003). Using a mouse also increases upper limb muscle loading in the hand,

forearm, and shoulder (Fogleman & Brogmus, 1995; Harvey & Peper, 1997; Cook, Burgess-Limerick, & Chang, 2000; Blatter & Bongers, 2002; Bystrom, Hansson, Rylander, Ohlsson, Kallrot, & Skerfving, 2002). In addition, a recent meta-analysis of 12 studies found a positive association between computer use and carpal tunnel syndrome in office workers (Shiri & Falah-Hassani, 2015).

Shoulder activity increases for postures that require abduction when the mouse is farther from the body (Harvey & Peper, 1997). Studies have suggested that shoulder pain is associated with sustained, low level muscle activity (Karwowski, Eberts, Salvendy, & Noland, 1994; Mathiassen, 2006). Studies of computer workers have shown limited variation in electromyography (EMG) over long periods (Ciccarelli, Straker, Mathiassen, & Pollock, 2013). Similarly, neck pain is associated with repetitive exposure, high job demands, and poor computer workstation set-up (Bongers, IJmker, & van den Heuvel, 2006; Cote, van der Velde, & Cassidy, 2009; McLean, May, & Klaber-Moffett, 2010).
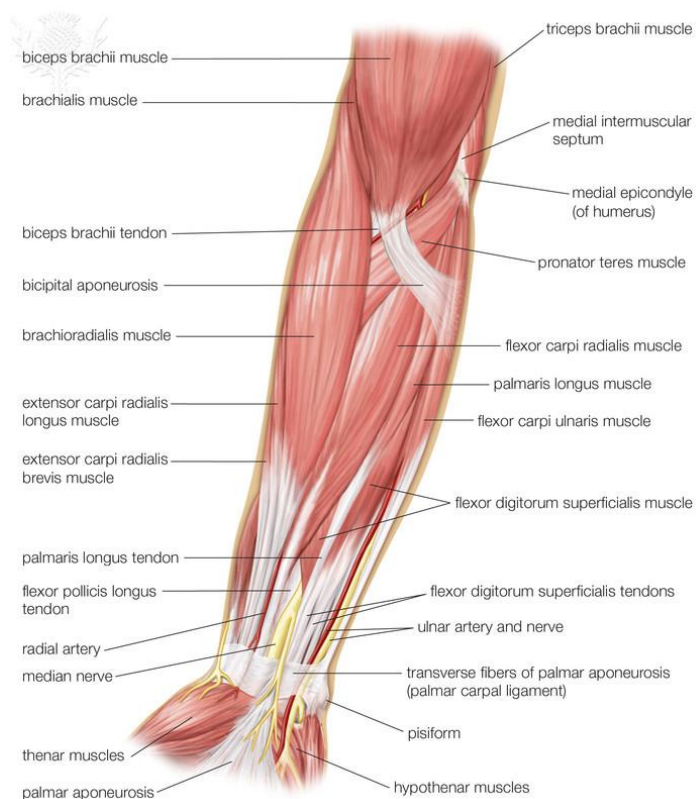
Figure 5:Muscles of the forearm. (Muscles of the forearm. [Illustration]. Retrieved from Encyclopædia Britannica ImageQuest.)
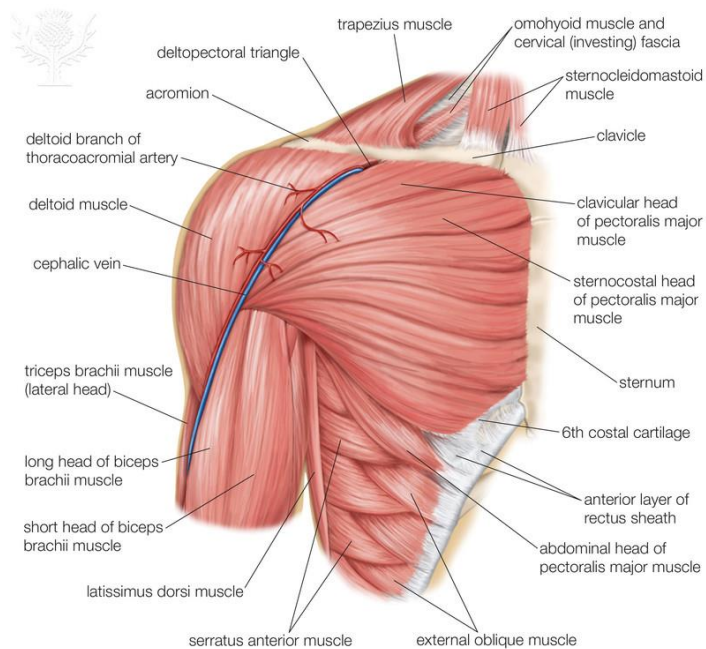
Figure 6: Shoulder and upper arm muscles. (Muscles of the upper limb. [Illustration]. Retrieved from Encyclopædia Britannica ImageQuest.)

Pointing Device Designs and Interventions

Studies have explored mouse design and implications for biomechanical risks. An

early study compared a trackpoint on a keyboard to a standard mouse and found

that while the trackpoint decreased compared to shoulder muscle load, it

increased forearm muscle load, suggesting that device location and design have

tradeoffs (Fernstrom & Ericson, 1997). Another 1997 study that used surface

electromyography to compare a right located standard mouse with a centrally

located trackball found significantly higher shoulder muscle activity with the

standard mouse (Harvey & Peper, 1997). Studies of "ergonomically" designed

devices that reduce forearm pronation and ulnar deviation have shown a

reduction in the risk of cumulative trauma disorders (Straker, Pollock, Frosh,

Aaras, & Dainoff, 2000; Aaras, Dainoff, Ro, & Thoresen, 2002; Fagarasanu &

Kumar, 2003). A study by Quemelo & Vieira (2013) found significant differences

in posture and forearm muscle activity between a vertical mouse and a standard

mouse. Other studies have shown higher forearm and shoulder muscle activity

in trackpads as compared to standard mice (Lee & Su, 2008; Lee T.-H. , 2005).

Sommerlich, Star, Smith &Shivers (2002) found less neutral postures and

increased discomfort when participants used a notebook computer trackpad

instead of a standard mouse, and lower shoulder muscle activity when the

numberpad was removed and the mouse was brought closer to the center of the

body. Another study changed the click button on a standard mouse to control in

finger-force direction and suggested that devices that do not require a "finger-

lift" decrease muscle activity and MSD risk (Lee, Mcloone, Kotani, & Dennerlein, 2007).

Dennerlein and Johnson (2007) used a repeated-measures study with four mouse locations to study the location effect of the device, relative to the user's centerline, on biomechanical risk factors. They found that placing the mouse closer to the center of the body either directly in front of the keyboard or to the right of a small keyboard without a numberpad decreased non-neutral postures and reduced ulnar deviation, wrist extension, and shoulder rotation. They found that the standard mouse position to the right of a full-size keyboard was associated with the lowest forearm and shoulder activity, but the centered mouse produced similar results. The high mouse location (50 mm above the keyboard on a platform) was associated with the highest muscle activity and the least neutral wrist and shoulder postures.

Other studies have investigated the location of pointing devices with respect to forearm support. Forearm support has been shown to reduce trapezius muscle activity and reduce the differences among different devices (Laursen, Jensen, & Jorgensen, 2002). Sako et al. (2014) found a significantly lower cardiorespiratory stress response when the mouse was positioned such that the shoulder was forward distally 15° and the forearm was resting on the desk when compared with the shoulder in line with the body and just the wrist on the desk. However, the benefits of forearm support are not well understood and some studies have

suggested they may cause worse postures and muscle loading (Aaras, Horgan, Bjorset, Ro, & Thoresen, 1998) (Cook, Burgess-Limerick, & Papalia, 2004).

The size of mouse also has an effect on muscle loading and posture. Oude Hengel, Houwink, Odell, van Dieen & Dennerlein (2008) studied 5 different sized mice with 30 people and observed the worst forearm and wrist postures and muscle activity with the smaller mice. The participants with the smallest hands had the least neutral postures, but the participants with larger hands were most affected by the smaller mice. This suggests there may be a fit problem with standard mice; however ulnar deviation observed with all of the mice exceeded ergonomic recommendations (Marcus, et al., 2002).

Previous research has suggested that some commercial device designs are safer than others. Lin, Young, and Dennerlein (2014) recently studied four different pointing devices: a standard mouse, trackball, trackpad, and rollermouse. Their study used electromyography to record muscle activity and motion analysis to study posture for 12 participants during pointing, clicking, and scrolling tasks (survey and game). They found more neutral postures and lower forearm extensor muscle activity for the two centrally located devices (trackpad and rollermouse), suggesting that a pointing device's location in relation to the body has an effect on muscle activity. The right located devices were also associated with greater shoulder abduction, flexion, and rotation. However, this study did not repeat devices in multiple locations, so the location effect was not fully

understood. Participants reported that the rollermouse was no more difficult to use than the other devices, and the mouse and rollermouse had the lowest discomfort levels. These results led the authors to suggest the roller-mouse as a good alternative pointing device.

Limited research beyond Lin et. al.'s study has been done to evaluate the rollermouse design. An earlier study found significantly decreased extensor digitorum and shoulder muscle activity in the rollermouse compared to a standard mouse (Kumar & Kumar, 2008). The tasks in this study lasted approximately one minute. These authors postulated that these differences were due to the rollermouse's location at the center of the body and its built-in wrist support. A workstation intervention study by Gravina, Lindstrom-Hazel and Austin (2007), introduced the rollermouse and saw it associated with more neutral shoulder postures. However, not all participants used the rollermouse since the standard mouse was not removed, and observations of rollermouse postures were limited. More research is needed to better understand how the rollermouse's design affects upper-body biomechanical postures and muscle activity.

Gender Differences

Women experience a higher rate of upper extremity disorders and injury than men, especially in the shoulder and neck (Punnett & Bergqvist, 1999; Gerr, et al., 2002; Lassen, Mikkelsen, Kryger, & Andersen, 2005; Treaster & Burr, 2004;

Wahlstedt, Norback, Wieslander, Skoglund, & Runeson, 2010; Hooftman, van der

Beek, Bongers, & van Mechelen, 2009; Paksaichol, Janwantanakul, Purepong,

Pensri, & van der Beek, 2012). A 2012 review of non-specific neck pain

prospective cohort studies found female gender as one of two significant

predictors out of forty-seven possible factors for neck pain (Paksaichol,

Janwantanakul, Purepong, Pensri, & van der Beek, 2012). These differences may

be more pronounced in younger, college-aged women, especially if they are

computer-science majors (Katz, Amick, Carroll, Hollis, Fossel, & Coley, 2000;

Hamilton, Jacobs, & Orsmond, 2005).

A 2011 review suggests this difference has many causes including

anthropometric differences, functional strength, motor control, fatigue

response, and psychosocial factors (Cote 2011). Women's tendons have been

shown to be more sensitive to overstretch (Burgess, Graham-Smith, & Pearson,

2008) and their shoulder joints are more flexible (Roy, MacDermid, Boyd, Faber,

Drosdowech, & Athwal, 2009). In height-matched men and women, women

were found to have smaller cervical (neck) vertebrae as well as smaller overall

anthropometric parameters (Vasavada, Danaraj, & Siegmund, 2007).

Females have less upper limb muscle strength and aerobic capacity (Faber,

Hansen, & Christensen, 2006) and have to use higher percentages of their

maximum voluntary contractions to perform the same tasks as males

(Nordander, et al., 2008; Haward & Griffin, 2002; Mogk & Keir, 2003). Other

studies have shown that women activate more accessory muscles and less

primary muscle groups than men in an isometric task at 50% maximum force

(Anders, Bretschneider, Bernsdorf, Erler, & Schneider, 2004). A study of the

shoulder muscles during a repetitive mousing task showed gender differences in

movement and fatigue strategies, which might explain the difference in injury

rates (Fedorowich, Emery, Gervasi, & Cote, 2012). These strength differences are

not only caused by smaller bones and muscles; muscle biopsies have shown that

women have a higher proportion of type 1 muscle fibers, which are the weakest

fibers (Lindman, Eriksson, & Prof, 1991; Jaworowski, Porter, Holmback,

Downham, & Lexell, 2002; Roepstorff, et al., 2006; Wust, 2008). Symptomatic

women have even less strength than asymptomatic women, which suggests that

strength directly affects MSD exposure and risk; however, because these were

already symptomatic the relationship is not well understood (Holterman,

Blangsted, Christensen, Hansen, & Sogaard, 2009). These functional differences

affect female workers' abilities and therefore may increase MSD risk (Cote,

2011).

A random sample study of 11,736 Canadian workers surveyed respondents for

musculoskeletal injury and risk exposures (Messing, Stock, & Tissot, 2009).

Females reported significantly higher neck, upper back, shoulder, and upper

extremity pain than males, with the highest difference in neck pain. The survey

responses indicated that MSD risk is correlated with psychosocial factors as well

as physical risk factors. Sitting posture, repetitive hand or arm movements,

intimidation at work and high psychological job demands were significantly associated with neck pain for both males and females, while unwanted sexual attention, greater than 40 hour work weeks, and greater than two children at home were significantly associated with neck pain for females only. This indicates that psychosocial factors may account for some of the differences between the genders.

Won, Johnson, Punnett & Dennerlein (2009) investigated gender differences in a study of 15 women and 15 men in a repeated-measures study with five standardized computer tasks, with multiple mouse locations for one of the tasks. Women had higher relative applied forces to the keyboard and mouse, as well as higher EMG readings in the extensor carpi radialis muscle (ECR) and flexor carpi radialis. They also had higher trapezius muscle activity, though this was not statistically significant. In addition, the female participants had more degrees of wrist flexion, external rotation, and wrist extension, which is consistent with the EMG readings. These differences were more pronounced in the less ergonomic position when the mouse was located above the keyboard. They also found correlations between anthropometric parameters (height, shoulder width, arm length, hand length) and biomechanical parameters for both genders. Smaller shoulders were correlated with higher ECR and trapezius muscle activity, and smaller anthropometry was correlated with larger postural deviations. When grouped by shoulder width instead of gender, four subjects changed grouping; i.e.: 2 men were part of the smaller group and 2 women were part of the larger

group, and when grouped by arm length, 6 changed. The differences between these groupings were more pronounced than the gender groupings, and many parameters became statistically significant. This suggests that anthropometry may play a larger role in the gender differences, and that more research is needed to explore this by specifically targeting males and females with similar anthropometry.

Research Questions

This study used electromyography (EMG) to study the relationship between muscle activity and different computer input devices across the female anthropometric spectrum. The first hypothesis was that there would be decreased forearm extensor carpi radialis (ECR) activity when using the rollermouse relative to the standard mouse and trackpad. The second hypothesis was that the center-located devices would reduce ECR and shoulder muscle (TRAP) activity relative to right-located devices. Finally, this study explored the impact of anthropometric differences on muscle activities. It was hypothesized that those with smaller anthropometry would have higher muscle activity relative to their maximum voluntary contractions, and that the biggest difference would be seen in the right-located devices when participants were grouped by shoulder width. Device, location, and anthropometric parameters were the independent variables, and measured EMG results and reported user experience feedback were the dependent variables.

Methodology

Participants

Twenty-one healthy, female participants were recruited from the Tufts

University community, with a targeted emphasis on women over 5'7" (170 cm)

or under 5'3" (160cm) which are approximately the 25th and 75th percentiles,

respectively. One participant was excluded from analysis due to experimental

error. Participants were screened for upper extremity musculoskeletal disorders

(UEMSD) and contraindications with skin adhesives. For device treatment order

counterbalancing, participants were grouped by height. Group A is the smaller

group and group B is the larger group. All participants were assigned a numerical

identifier. A summary of anthropometric data are in Table 1 and full participant

details are in the Appendix. T tests were used for pair-wise comparisons

between the two groups, and the differences were significant for height,

shoulder width, arm length, hand length, and wrist circumference. There was an

approximately 4cm difference between the tallest person in the short group and

the shortest person in the tall group. The mean of the group A reflected the 20th

percentile for American females, and the mean of group B reflected the 95th

percentile for American females.

*Table 1: Participant Anthropometric Data. Participants were grouped by height for counterbalancing and the measures for each group are presented below. Means and standard deviation (in parentheses) are also reported for some measurements. T tests were used for pairwise comparisons. Significant values are indicated with ***

	Group A	Group B	P value (t-test)
N	10	10	
Max height (cm)	164.6	185.2	
Min height (cm)	150.3	168.5	
Average height (cm)	158.8 (4.9)	174.8 (4.2)	.000*
Average shoulder width (cm)	36.1 (3.39)	40.5 (1)	.005*
Average arm length (cm)	67.7 (3.49)	76.9 (3.1)	.000*
Average hand length (cm)	17.1 (.75)	18.4(.61)	.001*
Average wrist circumference (cm)	14.7 (.94)	15.7 (.64)	.018*

Experiment Setup

All experiments took place in Bray Laboratories at Tufts University. All EMG measurements were recorded with a Noroxan™ MR3 Clinical DTS system (Scottsdale, AZ). All computer activities took place on a Windows 7 desktop computer. The computer activities were presented as separate tabs in a Google Chrome window. As shown in Figure 7 the monitor was lifted to improve eye

angle and kept constant for all participants, and the chair and footrests were

adjusted for each participant to ensure the table was at elbow height,

approximately 90 degree bent knees, and flat feet. Participants were

encouraged to use the arm rest and table for forearm support. A standard

keyboard with an attached number pad was provided to align the right-sided

devices and for completing the qualitative surveys. All trials were video

recorded using the Noroxan™ myoMuscle software and a HP laptop video

camera.
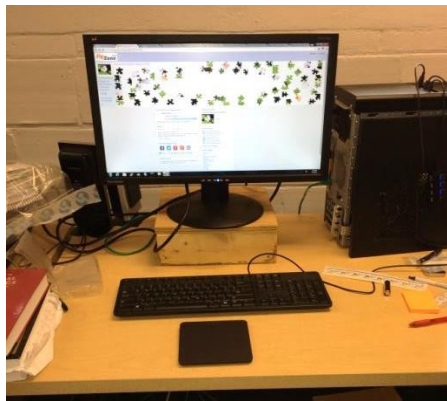
Figure 7: Experiment setup with the Dell monitor and keyboard. This shows the trackpad in the center location and the puzzle on the screen. Participants were positioned directly in front of the monitor.

Devices

The three test devices were: a standard Dell mouse (Figure 9), a Logitech

Touchpad T650 trackpad (Figure 10), and a Countour Rollermouse Free-2 (Figure

11).

Figure 8: Experiment setup with participant positioned with her elbows at table height and the sensors on her ECR and TRAP muscles. This shows the trackpad in the right location.

Figure 9: Dell ™Standard Mouse. It features two buttons: left click with pointer finger and right click with middle finger and a scroll wheel.

Figure 10: Logitech ™ Touchpad®. It is a completely flat surface with sensors. One finger will point, click, and drag. The bottom right corner is for "right click". Two fingers will scroll up and down or side to side. Two fingers pinching will zoom in or out. Three and four finger gestures change the window in view.

Figure 11: Contour Design Rollermouse ® A: rollerbar for pointing, clicking, and dragging using any combination of fingers. B: left click. C: right click. D: scroll. E:double click

In addition, the standard mouse and trackpad were tested in both the center (conventional for trackpad) and to the right of the keyboard (conventional for mouse). Each setup is shown in Figure 12. Each condition for device and location was treated as a separate independent variable for five total treatments. Treatment order was counterbalanced using a Latin Square design within each height group so that two from group A and two from group B were assigned to each order (Table 2).

Figure 12: Device and location treatment conditions. A-right mouse, B-center mouse,C- right trackpad, D-center trackpad, E-rollermouse.

Table 2: Counterbalanced Device Order

Order	Device 1	Device 2	Device 3	Device 4	Device 5
1	Right Mouse	Center Mouse	Right Trackpad	Center Trackpad	Rollermouse
2	Center Mouse	Right Trackpad	Rollermouse	Right Mouse	Center Trackpad
3	Right Trackpad	Rollermouse	Center Trackpad	Center Mouse	Right Mouse
4	Center Trackpad	Right Mouse	Center Mouse	Rollermouse	Right Trackpad
5	Rollermouse	Center Trackpad	Right Mouse	Right Trackpad	Center Mouse

Tasks

The experimental procedure utilized computer-based quizzes for scroll and click tasks (Figure 14) and an online puzzle for a click and drag task (Figure 15). These tasks were chosen based on the tasks used in previous research to motivate the typical mouse tasks: clicking, dragging, and scrolling. The two measured muscles are shown in Figure 13. In a neutral wrist, the ECR should not be activated by these tasks because they are finger gestures. The ECR is a wrist extensor and should only be activated when the wrist is extended. Similarly, the TRAP muscle should not be affected by mouse use unless it is compensating for weaker muscles or awkward postures. It will also be activated when there is inadequate arm support. Participants were told to move onto the next quiz/puzzle if they finished before the allotted time was up (two minutes for quiz and three minutes for the puzzle).
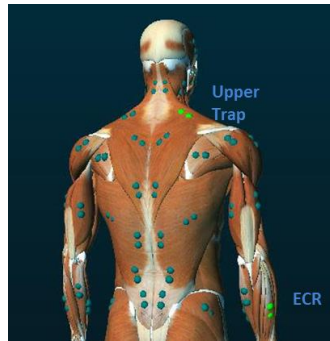
Figure 13: Location of upper TRAP muscle on posterior shoulder and ECR on forearm. Noraxon MyoMuscle.
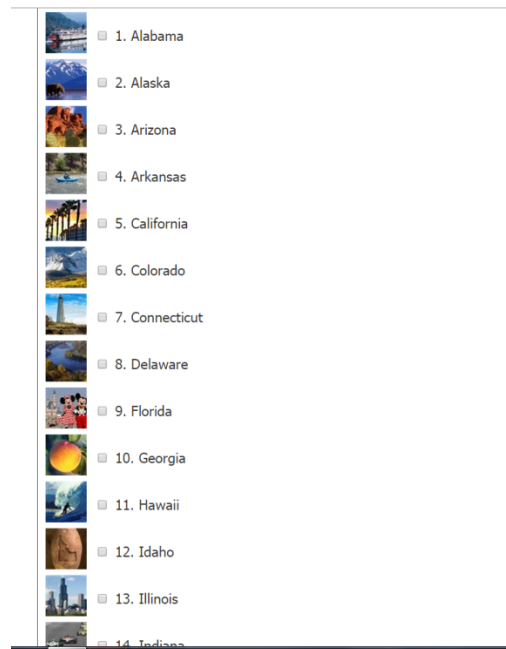
Figure 14: Example scroll and click task from listchallenges.com. In this quiz, participants had to pick the states they'd been to using each of the devices. They were not required to use a specific gesture or control, but most chose to "scroll" either by the scroll wheel on the mouse and rollermouse or with two fingers on the trackpad rather than drag the scroll bar at the right of the screen.
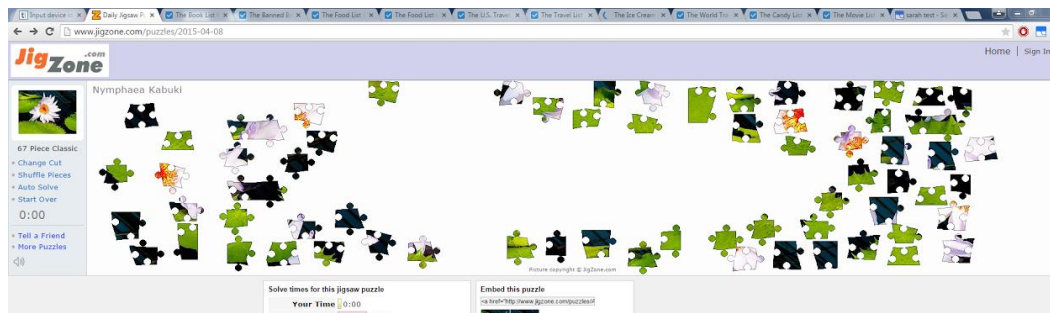
Figure 15: Example click and drag task from jigzone.com. Participants had to complete the puzzle using the devices to click and drag the puzzle pieces around the screen.

All test procedures and consent forms were reviewed and approved by Tufts University Institutional Review Board.

Qualitative Surveys

After each trial, participants completed a 6 question survey that asked for the device, location, familiarity, comfort, and difficulty of each. The familiarity, comfort, and difficulty questions were presented as likert scales (1=low,5=high), and the 6th question allowed for open-ended responses. Additionally, participants were invited to share overall feedback in an open-ended prompt at the end of the experiment. These questions are presented in Appendix B.

Experimental Protocol

All participants received electronic copies of the experimental procedure and consent form prior to the study, and they were given as much time as they needed to review both before signing the consent form with the researcher.

1. Participants were first measured for the following anthropometric values:

   - Height: Participants stood with their backs against a paper-covered door, and researcher marked height on paper, which was measured later with a tape measure.

   - Shoulder width: Measured on the back from acromion to acromion (bone on the shoulder blade) with a tape measure.

   - Wrist circumference: Measured at base of hand with tape measure.

   - Arm length: Measured along straight arm from acromion to middle fingertip with tape measure

   - Hand length: Participants placed their right hand on a piece of paper, and researcher marked outer base of hand (lunate bone) and middle fingertip, which was measured later with a tape measure.

   - Hand width: Marked both sides of base of hand (lunate and TRAPezium bones) and outer base of 1st and 4th digits. These were measured later with a tape measure, but these were not included in analysis due to inconsistent measurements which might have been due to soft-tissue fluctuations or measurement error.

2. Participants sat in chair, which was adjusted so that participants' elbows were at the same height as the desk. Footrests were provided so that participants' feet were flat with thighs parallel to the ground.

3. Noraxon EMG skin sensors were applied to the extensor carpi radialis (ECR) on the forearm and upper TRAP on the shoulder (Figure 13). The approximate ECR

location on the pronated forearm was identified and participants were asked to extend the wrist and feel for themselves where the muscle was. The researcher then palpated the muscle to confirm location before placing the sensor. The TRAP was found by shrugging and again asking participants to first identify where they felt the muscle contractions before the researcher confirmed location and placed the sensor. Participants were asked to flex to confirm muscle placement by watching the feedback from the software with wrist extension and TRAP activation.

4. Participants were asked to create a maximum voluntary contraction (MVC).

5. Participants were introduced to the experiment device and allowed up to two minutes for acclimation. Centered devices were aligned with the center-line of the participant's body, and right-side devices were placed to the right of the keyboard.

6. Participants took a two minute quiz (scroll and click task) and completed a puzzle (click and drag task) for three minutes.

7. Participants took a 6-question qualitative survey about their experience.

8. Participants repeated steps 5-7 with the remaining four devices. The order was counterbalanced within the two height groups.

Data Collection and Analysis

All EMG data were recorded using the Noraxon myoMUSCLE software at a sampling rate of100 Hz. Because muscle contractions vary greatly among people, a max voluntary contraction (mvc) was calculated for each participant to allow for normalization within participants (Harvey & Peper, 1997; Gazzoni, 2010). Real-time processing was

unsuccessful during the experiment, so each signal was normalized to the MVC post-process. All data were imported into Excel® (Microsoft, Redmond, WA), and median and peak EMG values for each trial were found as a percentage of the MVC. These values were verified by watching the video, and errant values (participant sneezed, took hand off device, etc.) were excluded. The two tasks for each device were analyzed together because they were consistent for each trial and the individual task responses were not the focus of the study. The tasks were designed to require the most common mousing tasks over a five minute period (pointing, clicking, dragging, and scrolling). The median was found to be a better dependent measure because there were many peaks over the 5 minute period that were hard to identify as true values and used for the majority of the analysis.

Means and standard deviations were calculated for the dependent variables (EMG %MVC, survey responses), and variation across treatments was tested using a repeated measures analysis of variance with significance levels of 0.10 and 0.05 which were chosen based on previous studies in the literature. The means for each participant across the devices were used to fill in the missing condition (right rollermouse). The proportional EMG data were tested for normality, which was violated. The median %MVC data were all less than 20% and needed to be transformed using an arcsin-square root transform (Horsley). Order, groups, and anthropometry were included in the models. In addition to large and small groupings for height, shoulder width, arm length, and hand length, quartiles were recorded for anthropometric data to better explore the differences across the spectrum. Groups were created such that there were 10 in each group (A is small and B is large), and quartiles were created with respect to the median and do not necessarily have equal n in each. The height and arm length groups were

identical, but the quartiles were different. Statistical analysis was completed in SPSS

(IBM, Armonk, NY).

Results

Devices and Locations

Devices

To test the first hypothesis that there would be a difference among devices, means were calculated for the median %MVC values for each trial across participants.

Table 3: Means and standard deviations of device %MVC medians for ECR and TRAP muscles with locations combined.

	Mouse	Trackpad	Rollermouse
ECR	6.526 (2.152)	8.612 (2.882)	8.042 (2.323)
TRAP	2.929 (3.243)	3.546 (4.253)	4.307 (3.619)

The highest measured muscle activity for the ECR was during trackpad use, and the highest muscle activity in the TRAP was during rollermouse use (Table 3). Shown in Figure 16, the medians for each device were similar for ECR. The mouse had the lowest mean for median ECR and TRAP activity, but it has more outliers (Figure 16 and Figure 17). The ECR values were strongly correlated within subjects (r=.780-.898 , N=20, p>.001) across all devices. For the TRAP, the right mouse was correlated with the right trackpad (r=.596 , N=20, p=.006) and rollermouse (r=.539 , N=20, p=.014), the center trackpad was correlated with the center mouse (r=.687 , N=20, p=.001), and the rollermouse was correlated with the center trackpad (r=.451 , N=20, p=.046).
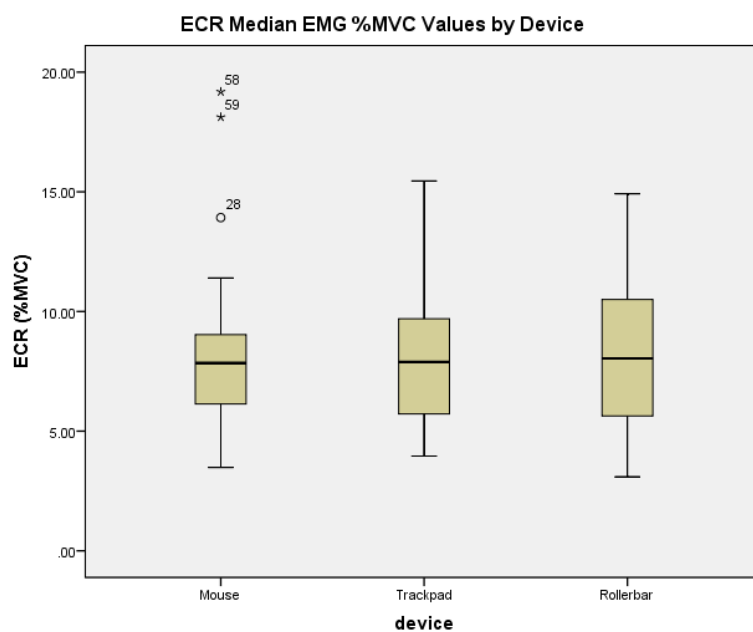
Figure 16: Median EMG values for the ECR muscle across devices. While the means were higher for the trackpad and rollermouse, the medians were similar across devices. As shown in the plot, there were outliers for the mouse.
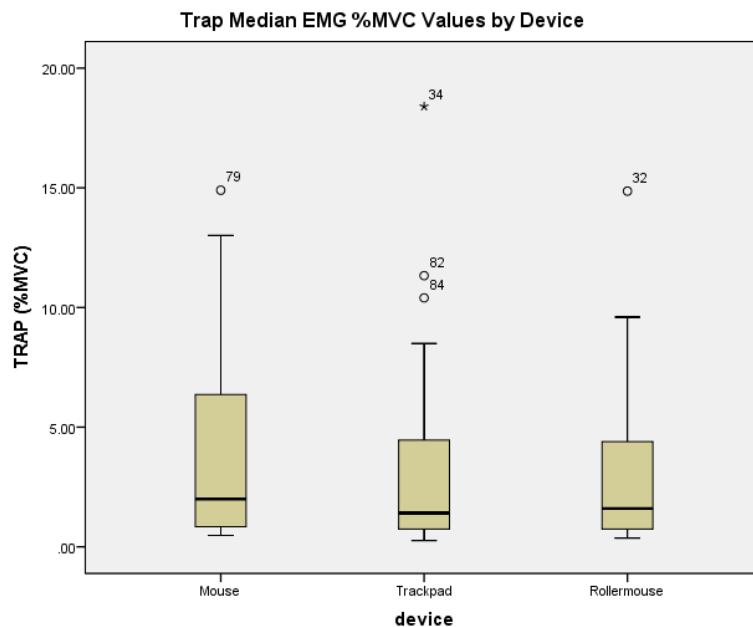
Figure 17: Median EMG values for the TRAP muscle across devices. While the means were higher for the trackpad and rollermouse, the medians were similar across device, and the mouse had the highest. As shown in the plot, there were outliers for all three devices.

The median values for peak EMG values were larger for the trackpad and rollermouse (Figure 18, Figure 19), though the mouse still had outliers.
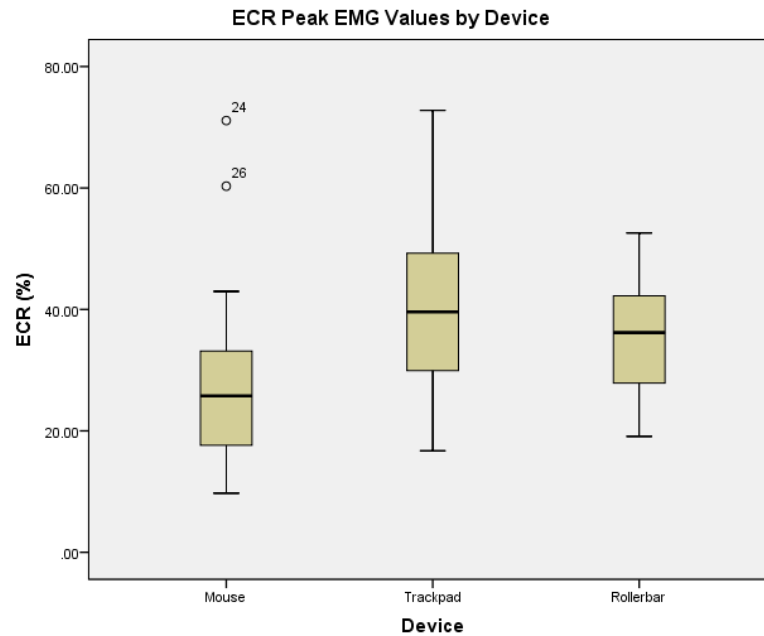
Figure 18: ECR peak EMG values for each device across all participants.
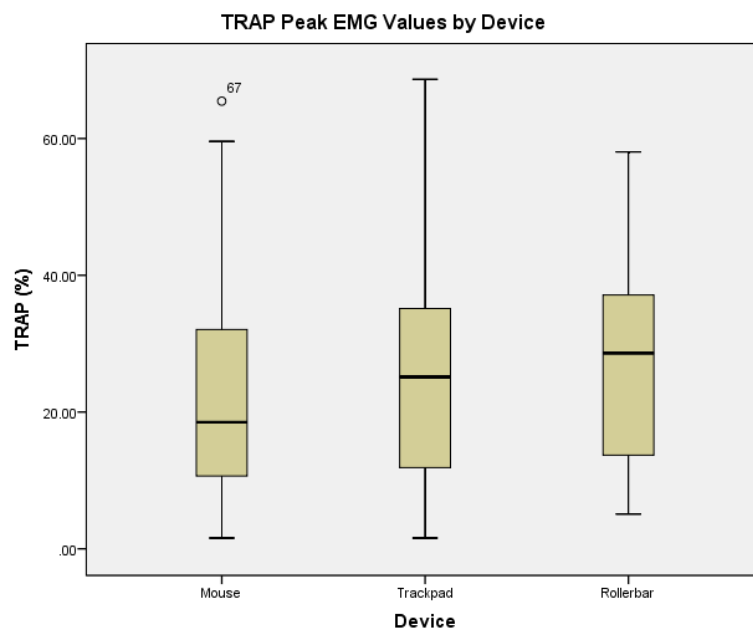
Figure 19: TRAP peak EMG values for each device across participants.

Locations

It was expected that the center location would have lower median muscle

activity than the right location. As shown in Figure 20 and Figure 21, location had

less of an effect than device did on the median EMG values for both muscles,

though the median for the center location in the trackpad was slightly lower.

The rollermouse was not repeated in the right location, so its higher mean may

artificially raise the center location median, especially in the TRAP muscle. There

is a larger spread for the center location in both muscles, which was not

expected due to the differences in anthropometry across participants.
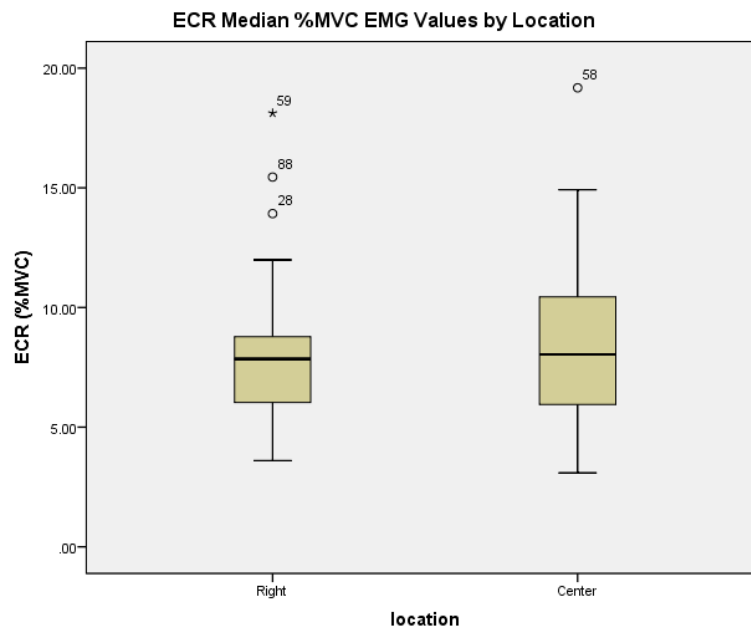
Figure 20: Median EMG values for the ECR muscle across locations
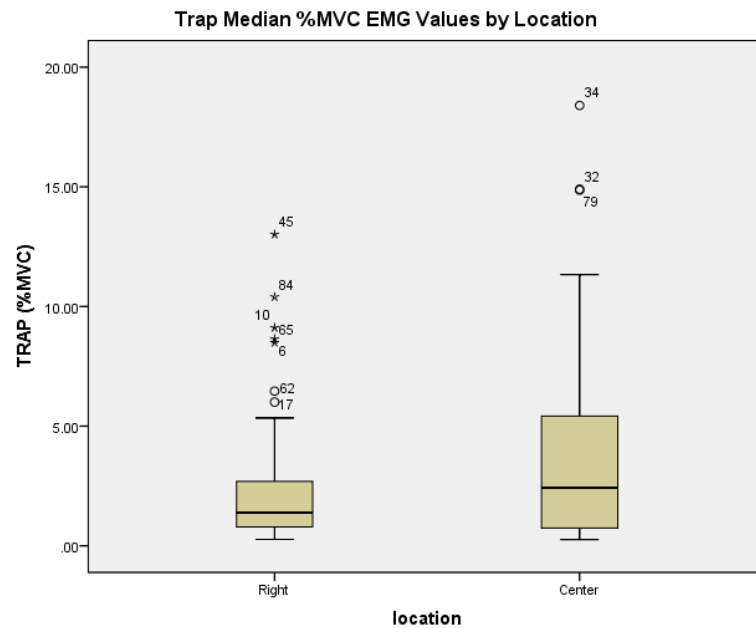
Figure 21: Median EMG values for the TRAP muscle across locations

Devices and Locations
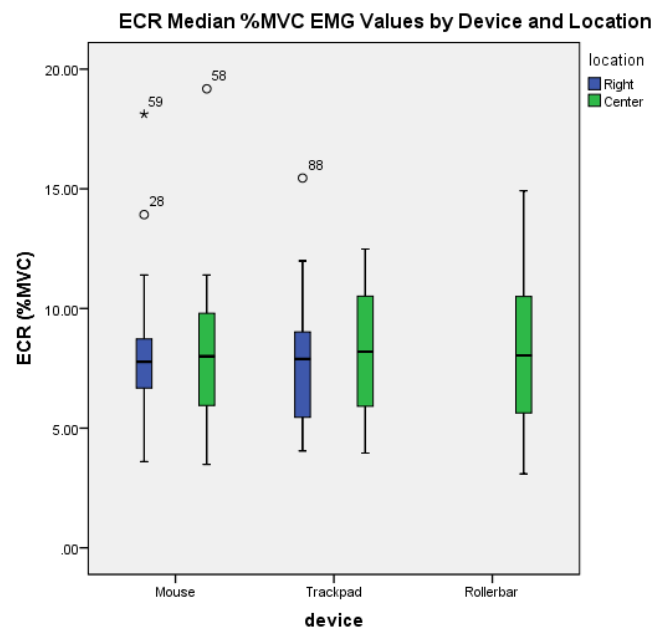
Figure 22: Median EMG values for the ECR muscle across devices and locations
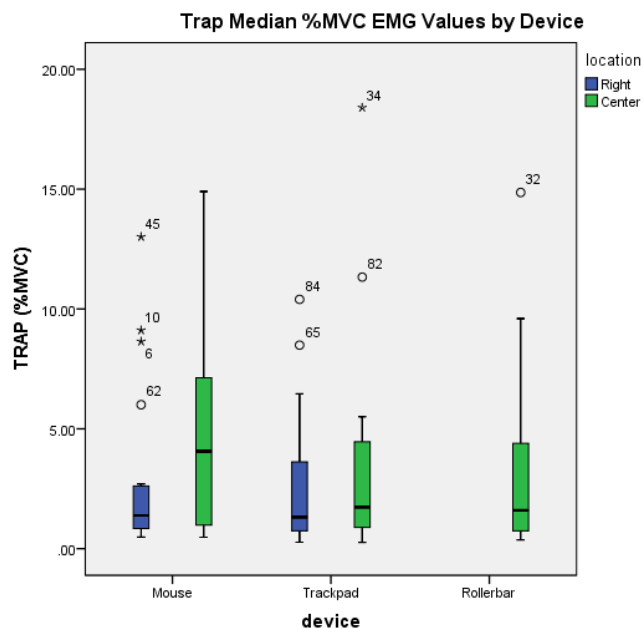
Figure 23: Median EMG values for the TRAP muscle across devices and locations

The different locations and devices are shown in Figure 22 and Figure 23. Means for the

median %MVC data for each treatment are shown in Table 4. It was expected that the

right location would cause higher muscle activity; however this only occurred for the

ECR muscle in the trackpad, though the difference was not statistically significant

(9.3023 vs. 9.0431, t(18)= .749, p=.463).

The means and transformed repeated-measures ANOVA results for devices and

locations are shown in Table 4. The observed power for detecting device as a main

effect was .531 in ECR and .271 in TRAP. The observed power for detecting location as a

main effect was .050 in ECR and .093 in TRAP. This difference was only marginally

significant at the 0.10 level in ECR (F(2,18) =2.894, p=.068). Post-hoc test with the

Bonferroni correction indicated that the differences among device means were

significant: mouse (transformed mean=.262, SE=.01) and trackpad (transformed mean=

.303, SE=.014) p<.0001; mouse and rollermouse (transformed mean=.288, SE=.011) p=.001; trackpad and rollermouse p=.01.

No significant difference was found for the TRAP muscle. The center location was higher for the mouse (3.253 vs. 2.355) and trackpad (4.492vs. 2.722). The rollermouse median %MVC mean was second highest at 4.092. This does not agree with the expectation that the center locations would cause lower shoulder muscle activity. Pair-wise t-test comparisons for the repeated devices (mouse, trackpad) did not show significant differences for either muscle between the two locations, but as stated above, the devices were correlated for ECR (r= r=.780-.898, p<.0001). Comparing devices in the same location (Table 4) shows significant differences between the mouse and trackpad in both locations for ECR (right: t(19)=-4.19, p<.0001; center: t(19)=-4.107, p=.001). The higher rollermouse mean was significant for ECR between the centered mouse and rollermouse (t(19)=3.532, p=.002) and between the centered trackpad and rollermouse(t(19)=-2.306, p=.033). Treating each condition as a separate device in a repeated measures ANOVA is not significant for TRAP and is significant at the 0.1 level for ECR (F(4,72)=2.058, p=.095, observed power= .587).

Table 4: Median treatment means and transformed ANOVA results for muscle activity with each device and location. Order is treated as a covariate. Data with outliers removed are also presented.

*significant at .05 **significant at .10

| | Median %MVC Device Means | | | | | | P-values | | |
| | Mouse | | Trackpad | | Rollermouse | | | | |
	Right	Center	Right	Center	Right (dummy)	Center	Device df=2	Location df=1	Device x Location df=2
ECR	6.8405	6.92518	9.3023	9.0431		8.39425	.068**	.987	.420
TRAP	2.35529	3.25361	2.72283	4.49242		4.09248	.274	.530	.613
ECR w/out outlier	6.551944	6.751306	8.673667	8.549667		8.041667	.001*	.010*	.000*
TRAP w/outlier	2.384872	3.472181	2.263144	4.827889		4.306972	.213	.542	.122

Anthropometry

To test the anthropometry hypothesis that smaller participants would have higher

muscle activity, participants were split by height groups& quartiles, shoulder width

groups& quartiles, arm length groups& quartiles, and hand length groups& quartiles.

The smaller groups are labeled A, and the larger groups are labeled B for all

anthropometric groupings. The quartiles are labeled 1-4 with 1 as the smallest and 4 as

the biggest. The means for each of these groupings are shown in Table 5 and Table 6.

Shown in Table 5, transformed means of the median %MVC EMG values were tested

using a repeated-measures ANOVA with anthropometric groupings as a factor and order

as a covariate. The means of the median %MVC for height groupings did not reflect the

expected outcomes. For the mouse, the smaller height group had lower ECR muscle

activity in the right location (6.7941 vs. 6.8869), but higher muscle activity in the center

location (7.1279 vs. 6.7225). The smaller height group had lower muscle activity in both

trackpad locations (9.1862 vs 9.4184 and 8.8756 vs. 9.2106) and the rollermouse

(8.2165 vs. 8.5720). For this grouping, device was marginally significant as a main effect

$(F(2,34)=2.756, p=.078)$. Observed power for device as a main effect was .508, and .050

for location. Paired- sample t-tests within devices were not significant. Splitting these

further into quartiles did not create significant results, and no trend was seen in the

means. The arm length grouping exactly reflected the height groupings and had the

same results.

When grouped by shoulder width, higher ECR activity was observed across most devices

in the smaller group (right mouse: 7.1622 vs. 6.5188, center mouse:7.2948 vs. 6.5556,

right trackpad: 9.3434 vs. 9.2612, center trackpad 9.3969 vs. 8.6893, rollermouse:

8.3027 vs. 8.4858) and was marginally significant for devices as a main effect

$(F(2,34)=2.924, p=.067$, observed power=.533). However, when split into quartiles, the

shoulder width quartile means did not follow a linear nor consistent relationship (right

mouse: 4<1<3<2; center mouse :4<2<1<3; right trackpad: 1<4<3<2; center trackpad:

1<4<3<2; rollermouse: 1<4<3<2). The 2nd and 3rd quartiles were consistently larger than

the 4th, and were larger than the 1st in all but the center mouse. This was significant for

device as a main effect $(F(2,34)=3.794, p=.034$, observed power= .646) and marginally

significant for device x location x shoulder quartile$(F(6, 34)=2.143, p=.077)$.

The larger hand group had higher measured %MVC muscle activity than the smaller

group did for all but the center trackpad condition (right mouse: 6.4572 vs. 7.2238;

center mouse: 6.7681 vs. 7.0823; right trackpad: 9.2378 vs. 9.3668; center trackpad:

9.0914 vs. 8.9948; rollermouse: 8.3872 vs. 8.4013). This was marginally significant for device (F(2, 34)=2.881, p=.070, observed power =.526).

None of the groupings were significant for the TRAP muscle in the repeated-measures ANOVA. The smaller height group mean median %MVC values were greater than the taller group in all but the right trqackpad (right mouse: 2.1940 vs. 2.5166; center mouse: 4.6289 vs. 1.8784; right trackpad: 2.2700 vs. 3.1756; center trackpad: 6.3465 vs. 2.6383; rollermouse: 3.9033 vs. 2.8633). Observed power was .261 for device as a main effect and .096 for location. Paired-samples t tests were not significant.

In addition, the smaller shoulder group mean median %MVC values were greater than the larger shoulder group, trending in the direction of the shoulder hypothesis (right mouse: 3.0193 vs. 1.6913; center mouse: 3.3870 vs. 3.1202; right trackpad: 3.0879 vs. 2.3578; center trackpad: 4.5445 vs. 4.4403;rollermouse: 3.5346 vs. 3.2320). Observed power was .325 for device and .107 for location. The means were less consistent across the quartiles (right mouse: 3<1<4<2; center mouse: 2<3<4<1; right trackpad: 3<1<2<4; center trackpad: 3<2<4<1; rollermouse: 3<4<2=1). Unlike the ECR results, the 3rd quartile remained lower than the 1st and 4th. Figure 24 shows the overall average within subjects across devices vs. shoulder width and Figure 25 shows that removing the 4th quartile shows a trend more consistent with the hypothesis, though this is not an exact linear relationship (R^2=.5374).
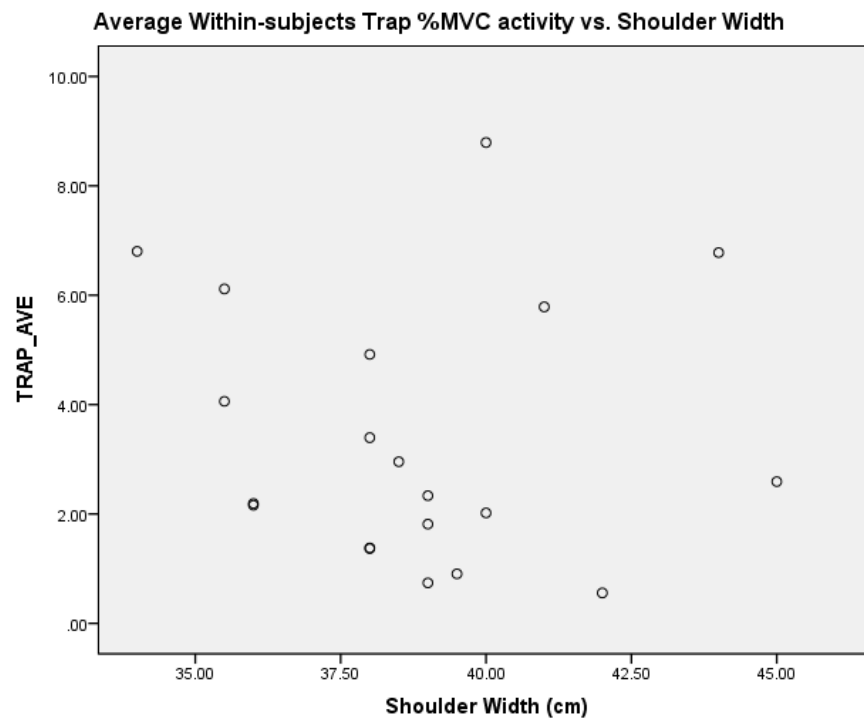
Figure 24: Shoulder activity within subjects across devices as a function of shoulder width. A negative linear relationship appears for smaller shoulder widths.
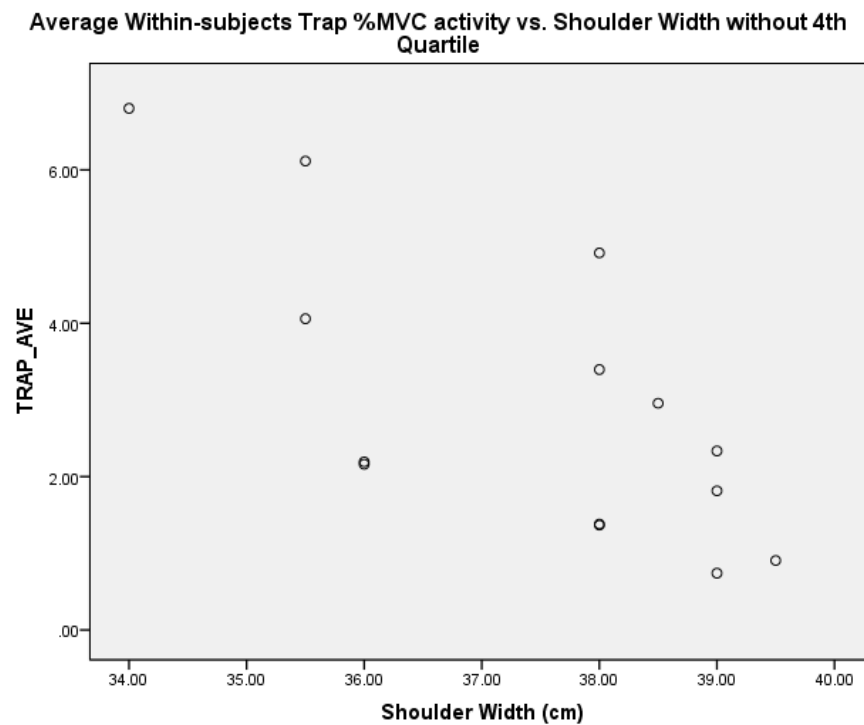
Figure 25: Shoulder activity within subjects across devices as a function of shoulder width without the 4th quartile is a more linear relationship. R^2=.537

Table 5: ECR device means when grouped by anthropometry parameters. P-values for repeated-measures ANOVA with transformed means are presented also.

*significant at .05. ** significant at .10

| | | ECR Median %MVC Device Means | | | | | | P-values | | | | |
| | | Mouse | | Trackpad | | Rollermouse | | | | | | |
		Right	Center	Right	Center	Right (dummy)	Center	Device Df=2	Device x group Df=2	Location Df=1	Location x group Df=1	Device x Location x group Df=2
Grouped by height	A, N=10	6.7941	7.1279	9.1862	8.8756	8.0401	8.2165	.078**	.868	.987	.866	.567
	B, N=10	6.8869	6.7225	9.4184	9.2106	8.1621	8.5720					
Height quartiles	1, N=5	7.3886	7.4939	9.1116	8.9618	8.2942	8.5150	.112	.108	.914	.108	.897
	2, N=5	6.1996	6.7618	9.2608	8.7894	7.7859	7.9180					
	3, N=4	6.0093	6.7533	6.4963	7.4043	6.8804	7.7388					
	4, N=6	7.4720	6.7020	11.3665	10.4148	9.0166	9.1275					
Grouped by shoulder	A, N=10	7.1622	7.2948	9.3434	9.3969	8.3000	8.3027	.067**	.665	.993	. 956	.330
	B, N=10	6.5188	6.5556	9.2612	8.6893	7.9021	8.4858					
Shoulder width quartiles	1, N=4	6.5285	7.3828	6.8478	7.5115	6.9619	6.5387	.034*	.140	.961	.601	.077**
	2, N=6	7.5847	7.2361	11.0072	10.6538	9.1921	9.4787					
	3, N=4	6.7662	7.8457	10.4255	9.5105	8.8886	8.8948					
	4, N=6	6.3538	5.6955	8.4850	8.1418	7.2445	7.5465					
Grouped by arm length	A, N=10	6.7941	7.1279	9.1862	8.8756	8.0401	8.2165	.078**	.868	.987	.866	.567
	B, N=10	6.8869	6.7225	9.4184	9.2106	8.1621	8.5720					
Arm length quartiles	1, N=5	7.3886	7.4939	9.1116	8.9618	8.2942	8.5150	. 136	.876	.963	.259	.705
	2, N=5	6.1996	6.7618	9.2608	8.7894	7.7859	7.9180					
	3, N=4	6.1534	6.9314	8.6724	8.8886	7.8299	8.5036					
	4, N=6	7.6204	6.5136	10.1644	9.5326	8.4943	8.6404					
Grouped	A, N=10	6.4572	6.7681	9.2378	9.0914	7.9883	8.3872	.070**	.841	.900	.401	.761

by hand length	B, N=10	7.2238	7.0823	9.3668	8.9948	8.2138	8.4013						
Hand length quartiles	1, N=3	5.1047	4.7380	6.5663	7.2843	5.8701	5.6573	.136	.947	.963	.259	.764
	2, N=7	7.0369	7.6381	10.327	9.8659	8.8961	9.5571					
	3, N=5	7.5980	8.2528	10.0504	9.3288	8.7418	8.4792					
	4, N=5	6.8496	5.9118	8.6832	8.6608	7.6858	8.3234					

Table 6: TRAP device means when grouped by anthropometry parameters. P-values for repeated-measures ANOVA with transformed means are presented also.

*significant at .05. ** significant at .10

| | | TRAP Device Means | | | | | | P-values | | | | |
| | | Mouse | | Trackpad | | Rollermouse | | | | | | |
		Right	Center	Right	Center	Right (dummy)	Center	Device Df=2	Device x group Df=2	Location Df=1	Location x group Df=1	Device x Location x group Df=2
Grouped by height	A, N=10	2.1940	4.6289	2.2700	6.3465	4.0773	3.9033	.287	.708	.518	.169	.117
	B, N=10	2.5166	1.8784	3.1756	2.6383	4.1077	2.8633					
Height quartiles	1, N=5	2.2243	3.8218	1.8163	5.9354	2.5439	3.2683	.399	.129	.585	.431	.251
	2, N=5	2.1636	5.4359	2.7237	6.7576	5.6107	4.5383					
	3, N=4	0.4770	2.0408	0.5756	0.4829	0.9029	0.8958					
	4, N=6	3.8764	1.7701	4.9090	4.0753	6.2442	4.1750					
Grouped by shoulder	A, N=10	3.0193	3.3870	3.0879	4.5445	3.6345	3.5346	.206	.303	.471	.414	.901
	B, N=10	1.6913	3.1202	2.3578	4.4403	4.5505	3.2320					
Shoulder width quartiles	1, N=4	2.0029	5.8864	2.9646	9.2355	5.3765	5.0932	.183	.092	.484	.066	.584
	2, N=6	3.6969	1.7208	3.1701	1.4172	2.4732	5.0932					
	3, N=4	0.9756	1.8057	0.8504	1.1463	2.4672	1.4490					
	4, N=6	2.1685	3.9968	3.3627	6.6363	5.9393	4.4207					
Grouped by arm length	A, N=10	2.1940	4.6289	2.2700	6.3465	4.0773	3.9033	.287	.708	.518	.169	.117
	B, N=10	2.5166	1.8784	3.1756	2.6383	4.1077	2.8633					
Arm length quartiles	1, N=5	2.2243	3.8218	1.8163	5.9354	2.5439	3.2683	.311	.108	.621	.528	.225
	2, N=5	2.1636	5.4359	2.7237	6.7576	5.6107	4.533					
	3, N=4	1.8965	3.0007	2.8459	1.4895	2.5371	2.3539					
	4, N=6	3.1367	0.7560	3.5054	3.7872	5.6782	3.3727					
Grouped by hand length	A, N=10	2.3680	4.7248	2.7530	4.9692	4.1571	3.7944	.351	.471	.486	.511	.436
	B, N=10	2.3426	1.7825	2.6927	4.0156	4.0279	2.9722					
Hand	1, N=3	3.4453	3.2132	4.2367	4.7627	4.9408	4.1197	.347	.541	.505	.443	.223

length quartiles	2, N=7	1.9063	5.3726	2.1171	5.0578	3.8211	3.6550					
	3, N=5	1.4796	2.8056	1.8771	5.2332	2.7421	2.8276					
	4, N=5	3.2055	0.7593	3.5083	2.7980	5.3137	5.3833					

The one-way ANOVA results for each of these factors are presented in Table 7. ECR was not significant for any anthropometric groupings. TRAP was marginally significant for the height groupings centered mouse (means: A: 4.6289, B: 1.8784; $F_{(1,18)}= 3.475$, p=.079), and for height quartiles for the mouse (means: 2.2243, 2.1636,0 .4770, 3.8764; $F_{(3,16)}=2.599$, p=.088), right trackpad (means: 1.18163, 2.7237,0 .5756, 4.9090; $F_{(3,16)}=5.538$, p=.008) and rollermouse (means: 3.2683,4.5383,0.8958, 4.1750; $F_{(3,16)}= 3.834$, p=.030). However, post-hoc Tukey tests revealed that this difference was due to a low mean for the 3rd quartile and a high mean for the 4th quartile (right mouse p=.057; right trackpad p=.006; rollermouse p=.052).

Similarly the low 3rd quartile affected the results for the center trackpad shoulder quartile result (means: 9.2355, 1.4172, 1.1463, 6.6363; $F_{(3,16)}=4.034$, p=.026), and the post-hoc Tukey test revealed 1st quartile was significantly different from the 2nd and 3rd quartiles (p=.05, .057).

The differences for the center mouse in the arm length (means: 4.6289, 1.8784; $F_{(1,18)}= 3.475$, p=.079) and hand length (means: 4.7248, 1.7825; $F_{(1,18)}= 4.025$, p=.060) were also marginally significant.

Table 7: One-way ANOVA for anthropometric factors.

*significant at .05. ** significant at .10

		One-way ANOVA p values				
		Mouse		Trackpad		Rollermouse
		Right	Center	Right	Center	Center
Grouped by height	ECR	0.978	0.705	0.957	0.956	0.825
	TRAP	0.938	0.079**	0.640	0.111	0.886
Height quartiles	ECR	0.595	0.958	0.280	0.544	0.253
	TRAP	0.088**	0.337	**0.008***	0.170	**0.030***
Grouped by shoulder	ECR	0.573	0.551	0.961	0.738	0.799
	TRAP	0.208	0.685	0.396	0.854	0.576
Shoulder width quartiles	ECR	0.851	0.570	0.434	0.535	0.250
	TRAP	0.359	0.261	0.299	**0.026***	0.258
Grouped by arm length	ECR	0.978	0.705	0.957	0.956	0.825
	TRAP	0.938	0.079**	0.640	0.111	0.886

Arm length quartiles	ECR	0.515	0.957	0.873	0.950	0.952
	TRAP	0.955	.141	0.839	0.392	0.245
Grouped by hand length	ECR	0.403	0.758	0.820	0.978	0.892
	TRAP	0.708	0.060**	0.806	0.653	0.747
Hand length quartiles	ECR	0.509	0.158	0.556	0.752	0.225
	TRAP	0.562	0.121	0.331	0.809	0.759

Qualitative Survey Data

Participants were all familiar with the mouse, and none were familiar with the rollermouse. Participants

marked different familiarity values for the different locations within the same device. Means for

familiarity levels are presented in Figure 26.
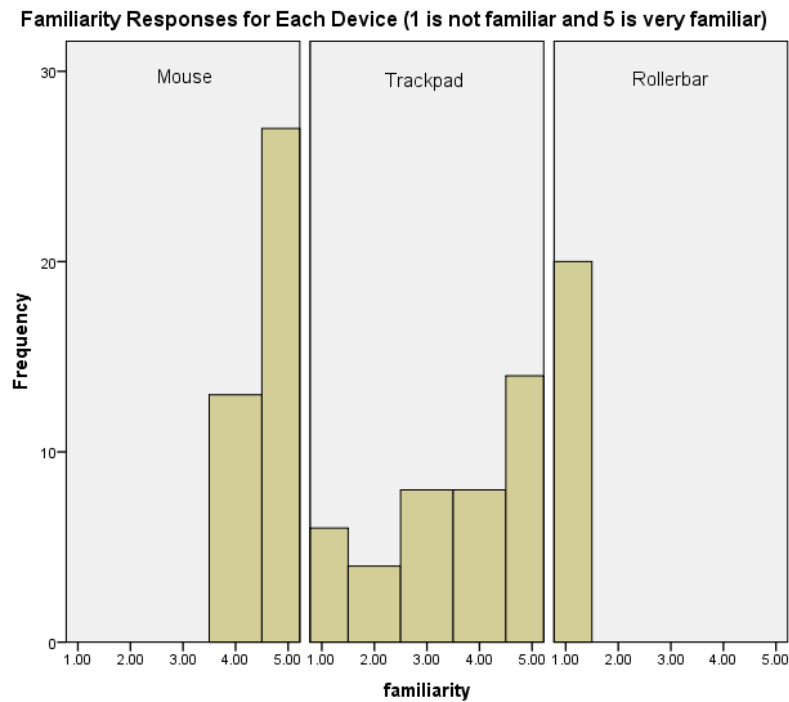
Figure 26: Frequency of familiarity responses for each device where 1 is "never seen before" and 5 is "use this all the time"

There was a significant difference in subjective responses for difficulty and comfort among

devices ($F_{(2,97)}$= 24.395, $p<.0001$; $F_{(2,97)}$=17.503, $p<.0001$) (Table 8). There was not a

significant difference between the two locations when the rollermouse was included in the

model; however, pair-wise comparisons between the two mouse locations revealed that

location was significant for perceived difficulty and comfort ($t_{(19)}$=3.387, p=.003; $t_{(19)}$=3.344,

p=.003) (Table 9).

Table 8: Means for subjective difficulty and comfort responses across devices. 1 is low (very difficult, uncomfortable) and 5 is high(not difficult, very comfortable). One-way ANOVA results are also presented.

	Means			F (2,97)	P-value
	Mouse	Trackpad	Rollermouse		
Difficulty	4.3	2.6	3.1	24.395	**<.0001**
Comfort	4.1	2.6	2.9	17.503	**<.0001**

Table 9: Pair-wise t-test comparisons for different locations of mouse and trackpad.

	Mouse		Trackpad	
	t(19)	p	t(19)	p
Difficulty	3.387	**.003**	-1.876	.076
Comfort	3.344	**.003**	-.195	.847

There were some significant correlations. Perceived discomfort and difficulty were positively correlated (r=.808, p<.0001). For the center trackpad, height was negatively correlated with perceived difficulty (r=-.463, p=.04), and shoulder width was negatively correlated with perceived difficulty and comfort (r=-.476, p=.034; r=-.592, p=.006), suggesting that the trial was easier for smaller participants. This agrees with the hypothesis that the center location is better for people with smaller shoulders. Similarly, perceived comfort for the right mouse was positively correlated with shoulder width(r=.417, p=.067), also agreeing with the hypothesis that the right location would be easier for larger subjects. Arm length was also negatively correlated with perceived difficulty for the center trackpad (r=-.524, p=.018). Hand length was negatively correlated with perceived difficulty for the center trackpad (r=-.479, p=.033), right trackpad (r=-.50, p=.025), and center mouse (r=-.403,p= .078).

Discussion

The goal of the study was to determine how different pointing devices and locations affected muscle activity, and if there was a difference based on different anthropometric parameters. There was a significant difference among devices; however, location did not have the expected effect. Observed power was low for most tests which suggests they were not sensitive to small effects; however, of post-hoc power analysis's significance in non-significant statistical tests is limited (O'Keefe, 2007). The rollermouse's increased muscle activity in both muscles is inconsistent with the limited previous research (Kumar & Kumar, 2008; Lin, Young, & Dennerlein, 2014). The trackpad's increased muscle activity is consistent with some of the literature (Lee & Su, 2008), but not consistent with Lin et al. (2014). Similarly, the lower muscle activity is consistent with Dennerlein's (2007) work, though a stronger difference between locations was expected (Sommerich, Starr, Smith, & Shivers, 2002).

Most of the anthropometric parameters in this study were not good predictors of muscle activity. The differences found do not agree with the hypothesis that smaller subjects would have higher muscle activity for most anthropometric groupings. This finding is not consistent with Won et al.'s finding; however, it is important to note that the previous study included men and the differences anthropometric measures were larger and had higher standard deviations for all parameters (2009). While the differences in anthropometry were significant between the two groups, they perhaps were not large enough. A follow-up study with more participants at each end of the anthropometric spectrum might show more significant results. Similarly, a mixed gender study with parameter-matched participants would further explore the relationship between anthropometry and muscle activity.

The interaction between shoulder width and muscle activity was consistent with previous research for participants with shoulders less than 40cm and suggests further exploration is needed into shoulder width and muscle activity. More participants at each end of the spectrum would help to better

understand these differences and if the bimodal high EMG results are a real phenomenon in the larger population or just a random observation in this particular study.

These results suggest that the differences among the three devices were so large that no other main effects were observed. This is likely due to the decreased usability with the trackpad which is less efficient and effective for precision tasks. It also requires more "click force" than the other devices, which previous studies have found presents more difficulty for females. Participants may have adopted non-neutral postures and used their ECR and TRAP muscles as compensation in order to achieve the required force. An increased baseline EMG result was observed in some trials, but was not clear if this was due to fatigue or the puzzle task.

While there were significant differences in perceived difficulty and comfort, these were not correlated to anthropometry or muscle activity. The highest perceived difficulty and discomfort were reported for the trackpad which had the highest muscle activity (except the right location TRAP results). Familiarity may have also had an effect; the trackpad was familiar enough that participants might have overestimated their ability to use it and did not spend the full acclimation period learning its controls. There was a correlation between the mouse familiarity scores and the median TRAP muscle activity as well as a correlation between trackpad familiarity and perceived difficulty and comfort. There was also a correlation between trackpad familiarity and center trackpad and rollermouse TRAP muscle activity.

The affordances among the three devices are also very different and provide different user experiences. The mouse only has three buttons and is inflexible in its use; e.g. left click is always left click. This prevents a lot of mistakes and makes its design preferable for precision work. The rollermouse also has buttons, but it incorporates redundancy (e.g. left click with either the button or the rollerbar) as well as more flexibility (e.g. the rollerbar is used for clicking and pointing). These aspects of the design make mistakes more likely, especially in study where it is so unfamiliar as compared to a standard mouse.

On the other hand, the trackpad has no buttons and no affordances. This makes the design less intuitive, and the gestures required to use it are not those commonly found in the real world: e.g. pinching to make something larger. The ubiquity of laptops and touchscreen smart phones has made these gestures common, so there is positive transfer for standalone trackpads; however, there can also be negative transfer when people are used to a particular scroll direction or getting feedback from a click. The extra multiple finger gestures make the likelihood of mistakes high and it increases user frustration. The poor user experience combined with the increased muscle activity found in this study and others indicates that the trackpad's design is an example as choosing form over function.

There was a considerable amount of variability between subjects. A larger sample size would likely prevent this between subjects difference from affecting the results. In this particular sample, the two smallest subjects had some of the lowest muscle activity, while the tallest had some of the highest. One participant was excluded from analysis because she exhibited so much difficulty using the trackpad during the experiment, but it is possible that there were others with similar finger-touchpad problems. Also, more background information about the participants would help to better understand confounding variables such as age, primary computer input device, years using a computer, average daily computer time, preferred operating system, race, etc.

Another limitation in the study was the desk and chair provided. The chair was only height adjustable, so the seat pan could not be adjusted for popliteal length. The table was not adjustable, and the monitor height was kept static across participants. Participants were fit to the desk and monitor height, but this lack of adjustability was a limitation. Similarly, the real estate on the desk was limited. Participants were encouraged to use the arm rest and table for forearm support, but this was not controlled nor measured in this study. Previous studies have suggested there may be an interaction

effect between visual display height and forearm support, but this is not well understood (Straker, et al., 2008).

Conclusion

This study explored the differences in electromyography results for different computer input devices across multiple anthropometric parameters in females. This is the first known study that looked at anthropometry and muscle activity in women. When controlling for task duration and gender, as well as following ergonomic guidelines for workstation setup, anthropometric parameters did not explain the differences between subjects. While the results did not reflect expected outcomes, this is an important first step to better understanding why there is a higher risk of musculoskeletal disorders in females. As previous reviews and studies have suggested, the higher rate of RSI in females does not have a simple explanation (Cote, 2011; Messing, Stock, & Tissot, 2009; Paksaichol, Janwantanakul, Purepong, Pensri, & van der Beek, 2012). More research is needed to draw conclusions about how anthropometry affects injury rates.

This adds to the body of literature describing the relationship between muscle activity and computer input devices. Though the rollermouse is designed to reduce "finger lift" and non-neutral postures, it did not demonstrate reduced muscle activity in the forearm or shoulder when compared to the standard mouse. Its benefits need to be better studied in users who are more familiar with its design to help account for usability effects. Similarly, risk from non-neutral postures during laptop trackpad use has been established, but trackpad use is only increasing among users of all ages (Hughes & Johnson, 2012).

The relationship between mouse use and MSD is established, but a good solution has not been discovered. More ergonomic research with alternative pointing devices is needed to understand the benefits of different designs. A "one-size fits all" approach may not exist; pointing device suggestions may need to be made based on multiple factors including anthropometry, sit/stand preference, and

types of tasks. Currently, guidelines exist for workstation setup with regards to chair, table, and monitor height, and different-sized mice exist for different hand sizes; however guidelines for keyboard and mouse placement based on shoulder width may be more beneficial.

References

Occupational Safety and Health Definitions. (2012, November 20). Retrieved from Bureau of Labor Statistics: http://www.bls.gov/iif/oshdef.htm

Aaras, A., Dainoff, M., Ro, O., & Thoresen, M. (2002). Can a more neutral position of the forearm and operating a computer mouse reduce the pain level for VDU operators? *International Journal of Industrial Ergonomics*, 307-324.

Aaras, A., Horgan, G., Bjorset, Ro, O., & Thoresen, M. (1998). Musculoskeletal visual and psychocosial stress in VDU operators before and after multidisciplinary ergonomic interventions. *Applied Ergonomics*, 335-54.

Anders, C., Bretschneider, S., Bernsdorf, A., Erler, K., & Schneider, W. (2004). Activation of shoulder muscles in healthy men and women under isometric conditions. *Journal of Electromyography and Kinesiology*, 699-707.

Atkinson, S., Woods, V., Haslam, R. A., & Buckle, P. (2004). Using non-keyboard input devices: interviews with users in the workplace. *International journal of industrial ergonomics*, 571-579.

Blatter, B. M., & Bongers, P. M. (2002). Duration of computer use and mouse use in relation to musculoskeletal disorders of neck or upper limb. *International Journal of Industrial Ergonomics*, 295-306.

Bongers, P., IJmker, S., & van den Heuvel, S. (2006). Epidemiology of work related nech and upper limg problems: psychosocial and personal risk factors (part I) and effective interventions from a bio behavioural perspective (part II). *Journal of Occupational Rehabilitation*, 279-302.

Burgess, K. E., Graham-Smith, P., & Pearson, S. J. (2008). Effect of acute tensile loading on gender-specific tendon structural and mechanical properties. *Journal of Orthopaedic Research*, 510-516.

Bystrom, J. U., Hansson, G., Rylander, L., Ohlsson, K., Kallrot, G., & Skerfving, S. (2002). Physical workload on neck and upper limb using two CAD applications. *Applied Ergonomics*, 63-74.

CDC. (2015, June 10). *Musculoskeletal Disorders*. Retrieved from Centers for Disease Control: http://www.cdc.gov/niosh/programs/msd/

Ciccarelli, M., Straker, L., Mathiassen, S., & Pollock, C. (2013). Variation in Muscle Activity Among Office Workers When Using Different Information Technologies at Work and Away From Work. *Human Factors*, 911-923.

Cook, C., Burgess-Limerick, R., & Chang, S. (2000). The prevalence of neck and upper extremity musculoskeletal symptoms in computer mouse users. *Industrial and Ergonomics*, 347-356.

Cook, C., Burgess-Limerick, R., & Papalia, S. (2004). The effect of upper extremity support on upper extremity posture and muscle activity during keyboard use. *Applied Ergonomics*, 285-92.

Cote, J. N. (2011). A critical review on physical factors and functional characteristics that explain a sex/gender difference in work-relatedneck/shoulder disorders. *Ergonomics, 55:2*, 173-182.

Cote, P., van der Velde, G., & Cassidy, J. (2009). The burden and determinants of neck pain in workers. Results of the bone and joint decade 2000-2010 task force on neck pain and its associated disorders. *Journal of Manipulative Physiological Therapy*, 70-86.

Dennerlein, J. T., & Johnson, P. W. (2007). Changes in upper extremity biomechanics across different mouse positions in computer workstations. *Ergonomics*, 1456-1469.

Edwards, B. (2008, December 9). *The computer mouse turns 40*. Retrieved June 2, 2015, from Macworld: http://www.macworld.com/article/1137400/mouse40.html

Engelbart, D. C. (1970, November). *Patent No. US3541541.* United States of America.

Faber, A., Hansen, K., & Christensen, H. (2006). Muscle strength and of aerobic capacity in a representative sample of employees with and without repetitive monotonous work. *International Archives of Occupational and Environmental Health*, 33-41.

Fagarasanu, M., & Kumar, S. (2003). Carpal tunnel syndrome due to keyboarding and mouse task: a review. *International Journal of Industrial Ergonomics*, 119-136.

Fedorowich, L., Emery, K., Gervasi, B., & Cote, J. N. (2012). Gender differences in neck/shoulder muscular patterns in response to repetitive motion induced fatigue. *Journal of Electromyography and Kinesiology*, 1183-1189.

Fernstrom, E., & Ericson, M. O. (1997). Computer mouse or trackpoint- effects on muscular load and operator experience. *Applied Ergonomics*, 347-354.

Fogleman, M., & Brogmus, G. (1995). Computer mouse use and cumulative trauma disorders of the upper extremities. *Ergonomics*, 2465-2475.

Gazzoni, M. (2010). Multichannel surface electromyography in ergonomics: Potentialities and limits. *Human Factors and Ergonomics in Manufacturing*, 255-271.

Gerr, F., Marcus, M., Ensor, C., Kleinbaum, D., Cohen, S., Edwards, A., et al. (2002). A prospective study of computer users: I. Study design and incidence of musculoskeletal symptoms in disorders. *American Journal of Industrial Medicine, 41*(4), 221-235.

Gravina, N., Lindstrom-Hazel, D., & Austin, J. (2007). The effects of workstation changes and behavioral interventions on safe typing postures in an office. *Work*, 245-253.

Hamilton, A. G., Jacobs, K., & Orsmond, G. (2005). The prevalence of musculoskeletal complaints in female college students. *Work*, 387-394.

Harvey, R., & Peper, E. (1997). Surface electromyography and mouse use position. *Ergonomics, 4*(8), 781-789.

Haward, B., & Griffin, M. (2002). Repeatability of grip strength and dexterity tests and the effects of age and gender. *International Archives of Occupational and Envirionmental Health*, 111-119.

Holterman, A., Blangsted, A. K., Christensen, H., Hansen, K., & Sogaard, K. (2009). What characterizes cleaners sustaining good musculoskeletal health after years with physically heavy work? *International Archives of Occupational and Environmental Health*, 1015-1022.

Hooftman, W. E., van der Beek, A. J., Bongers, P. M., & van Mechelen, W. (2009). Is there gender difference in the effect of work related physical and psychosocial risk factors on musculoskeletal symptoms in related sickness absence. *Scandinavian Journal of Work, Environment, and Health*, 85-95.

Horsley, R. (n.d.). *Transformations.* Retrieved from http://www.ndsu.nodak.edu/ndsu/horsley/Transfrm.pdf

Hughes, E. E., & Johnson, P. W. (2012). Children computer mouse use and anthropometry. *Work*, 846-850.

IJmker, S., Huysmans, M. A., Blatter, B. M., van der Beek, A. J., van Mechelen, W., & Bongers, P. M. (2007). Should office workers spend fewer hours at their computer? A systematic review of the literature. *Occupational & Environmental Medicine, 64*(4), 211-222.

Jaworowski, A., Porter, M., Holmback, A., Downham, D., & Lexell, J. (2002). Enzyme activities in the tibialis anterior muscle of young moderately active men and women: relationship with body composition, muscle cross-sectional area and fibre type composition. *Acta Physiologica Scandanavica*, 215-225.

Karlqvist, L., Hagberg, M., & Selin, K. (1994). Variation in upper limb posture and movement during word processing with and without mouse use. *Ergonomics, 37*(7), 1261-1267.

Karwowski, W., Eberts, R., Salvendy, G., & Noland, S. (1994). The effects of computer interface design on human postural dynamics. *Ergonomics*, 703-724.

Katz, J. N., Amick, B. C., Carroll, B. B., Hollis, C., Fossel, A. H., & Coley, C. M. (2000). Prevalence of upper extremity musculoskeletal disorders in college students. *The American Journal of Medicine*, 586-588.

Keir, P. J., Bach, J. M., & Rempel, D. (1999). Effects of computer mouse design and task on carpal tunnel pressure. *Ergonomics, 42*(10), 1350-1360.

Kumar, R., & Kumar, S. (2008). A comparison of muscular activity involved in the use of two different types of computer mouse. *International Journal of Occupational Safety and Ergonomics*, 305-311.

Lassen, C. F., Mikkelsen, S., Kryger, A. I., & Andersen, J. H. (2005). Risk factors for persistent elbow, forearm, and hand pain among computer workers. *Scandinavian Journal of Work, 31*(2), 122-131.

Laursen, B., Jensen, B., & Jorgensen, A. (2002). Effect of mental and physical demans on muscular activity during the use of a computer mouse and a keyboard. *Scandanavian Journal of Work, Envrionment, and Health*, 215-221.

Lee, F. J., Mcloone, H. E., Kotani, K., & Dennerlein, J. T. (2007). Alternative computer mouse design and testing to reduce finger extensor muscle activity during mouse use. *Human Factors*, 573-584.

Lee, T.-H. (2005). Ergonomic comparison of operating a built-in touchpad pointing device and a trackball mouse on posture and muscle activity. *Perceptual and Motor Skills*, 730-736.

Lee, Y.-H., & Su, M.-C. (2008). Design and validation of a desk-free and posture-independent input device. *Applied Ergonomics*, 339-406.

Leigh, J. P. (2011). Economic burden of occupational injury and illness in the United States. *The Milbank Quarterly*, 728-772.

Leigh, J. P., & Marcin, J. P. (2012). Workers' compensation benefits and shifting costs for occupational injury and illness. *Journal of Occupational and Environmental Medicine*, 445-450.

Liberty Mutual Research Institute for Safety. (2015, January 15). *Liberty Mutual Research Institute for Safety Releases 2014 Workplace Safety Index [press release].* Retrieved June 3, 2015, from Liberty Mutual Group: http://www.libertymutualgroup.com/omapps/ContentServer?pagename=LMGroup/Views/lmg View98&kw=false&cid=1240026874452

Lin, M., Young, J., & Dennerlein, J. (2014). Evaluating the effect of four different pointing device designs on upper extremity posture and muscle activity during mousing tasks. *Applied Ergonomics, 47*, 259-264.

Lindman, R., Eriksson, A., & Prof, L.-E. T. (1991). Fiber type composition of the human female trapezius muscle: histochemical characteristics. *Developmental Dynamics*, 385-391.

Marcus, M., Gerr, F., Monteih, C., Ortiz, D., Gentry, E., Cohen, S., et al. (2002). A prospective study of computer usersII. Postural risk factors for musculoskeletal symptoms and disorders. *American Journal of Industrial Medicin*, 236-249.

Mathiassen, S. (2006). Diversity and variation in biomechanical exposure: What is it, and why would be like to know? *Applied Ergonomics*, 419-427.

McLean, S., May, S., & Klaber-Moffett, J. (2010). Risk factors for the onset of non-specific neck pain: a systematic review. *Journal of Epidemiology and Community Health*, 565-572.

Messing, K., Stock, S. R., & Tissot, F. (2009). Should studies of risk factors for musculoskeletal disorders be stratified by gender? Lessons from the 1998 Quebec health and social survey. *Scandinavian Journal of Work and Environmental Health*, 96-112.

Mirka, G. A. (1991). The quantification of EMG normalization error. *Ergonomics, 34*(3), 343-352.

Mogk, J., & Keir, P. (2003). The effects of posture on forearm muscle loading during gripping. *Ergonomics*, 956-975.

Noack-Cooper, K. L., Sommerich, C. M., & Mirka, G. A. (2009). College students and computers: Assessment of usage patterns and musculoskeletal discomfort. *Work*, 258-298.

Nordander, C., Ohlsson, K., Balogh, I., Hansson, G., Axmon, A., Persson, R., et al. (2008). Gender differences in workers with identical repetitive industrial tasks: exposure and musculoskeletal disorders. *International Archives of Occupational and Environmental Health*, 939-947.

O'Keefe, D. J. (2007). Post Hoc Power, Observed Power, A Priori Power, Retrospective Power, Prospective Power, Achieved Power: Sorting out apparent uses of statistical power analyses . *Communication Methods and Measures*, 291-299.

Oude Hengel, K. M., Houwink, A., Odell, D., van Dieen, J. H., & Dennerlein, J. T. (2008). Smaller external notebook mice have different effects on posture and muscle activity. *Clinical Biomechanics*, 727-734.

Paksaichol, A., Janwantanakul, P., Purepong, N., Pensri, P., & van der Beek, A. J. (2012). Office workers' risk factors for the development of non-specific neck pain: a systematic review of prospective cohort studies. *Occupational and Environmental Medicine*, 610-618.

Punnett, L., & Bergqvist, U. (1999). Musculoskeletal disorders in visual display unit work: gender and work demands. *Occupational Medicine, 14*(1), 113-124.

Quemelo, P. R., & Ramos Vieora, E. (2013). Biomechanics and performance when using a standard and a vertical computer mouse. *Ergonomics*, 1336-1344.

Roepstorff, C., Thiele, M., Hillig, T., Pilegaard, H., Richter, E. A., Wojtaszewski, J. F., et al. (2006). Higher skeletal muscle α2AMPK activation and lower energy charge and fat oxidation in men than in women during submaximal exercise. *The Journal of Physiology*, 125-138.

Roy, J.-S., MacDermid, J. C., Boyd, K. U., Faber, K. J., Drosdowech, D., & Athwal, G. S. (2009). Rotational strength, range of motion, and function in people with unaffected shoulders from various stages of life. *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology*, 1-4.

Sako, S., Sugiura, H., Tanoue, H., Kojima, M., Kono, M., & Inaba, R. (2014). The position of a standard optical computer mouse affects cardiorespiratory responses during operation of a computer under time constraints. *International Journal of Occupational Medicine and Environmental Health*, 547-559.

Shiri, R., & Falah-Hassani, K. (2015). Computer use and carpal tunnel sundrome: A meta-analysis. *Journal of the Neurological Sciences*, 15-19.

Sommerich, C., Starr, H., Smith, C., & Shivers, C. (2002). Effects of notebook computer configuration and task on user biomechanics, productivity, and comfort. *International Journal of Industrial Ergonomics*, 7-31.

Straker, L., Burgess-Limerick, R., Pollock, C., Murray, K., Netto, K., Coleman, J., et al. (2008). The impact of computer display height and desk design on 3D posture during information technology work by young adults. *Journal of Electromyography and Kinesiology*, 336-349.

Straker, L., Pollock, C., Frosh, A., Aaras, A., & Dainoff, M. (2000). An ergonomic field comparison of a traditional computer mouse and a vertical computer mouse in injured office workers. *Proceedings of the IEA 2000/HFES 2000 Congress*, (pp. 6-356-359).

Treaster, D., & Burr, D. (2004). Gender differences in prevalence of upper extremity musculoskeletal disorders. *Ergonomics, 47*(5), 495-526.

Vasavada, A., Danaraj, J., & Siegmund, G. (2007). Head and neck anthropometry, vertebral geometry and neck strength in height-matched women and women. *Journal of Biomechanics*, 114-121.

Wahlstedt, K., Norback, D., Wieslander, G., Skoglund, L., & Runeson, R. (2010). Psychosocial and ergonomics factors, and their relation to musculoskeletal complaints in the Swedish workforce. *International Journal of Occupational Safety and Ergonomics*, 311-321.

Werner, R., Armstrong, T. J., & Aylard, N. K. (1997). Intracarpal canal pressure: the role of finger, hand, wrist, and forearm position. *Clinical Biomechanics, 12*, 44-51.

Wickens, C. D., Lee, J. D., Liu, Y., & Gordon Becker, S. E. (2004). *An Introduction to Human Factors Engineering* (2nd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Won, E. J., Johnson, P. W., Punnett, L., & Dennerlein, J. T. (2009). Upper extremity biomechanics in computer tasks differ by gender. *Journal of Electromyography and Kinesiology, 19*(3), 428-436.

Wust, R. C. (2008). Sex differences in contractile properties and fatigue resistance of human skeletal muscle. *Experimental Physiology*, 843-850.

Appendix A-Participant Anthropometry Details

Sub	Order	Height (cm)	Height group	Height Quart	Shoulder Width (cm)	Shoulder Group	Shoulder Quart	Hand length (cm)	Hand Length Group	Arm Length (cm)	Arm Group	Arm length Quart
1	5	150.3	A	1	36	A	2	17	A	66	A	1
2	2	150.5	A	1	39	B	3	17.1	A	66.4	A	1
3	2	157.4	A	1	35.5	A	1	18.2	B	67.5	A	1
4	5	157.6	A	1	36	A	2	16	A	68.3	A	1
5	3	159	A	1	35.5	A	1	17.4	A	68.5	A	1
6	3	164.6	A	2	40	B	4	17.1	A	69	A	2
7	4	160.5	A	2	34	A	1	16.4	A	69.5	A	2
8	1	164	A	2	38	A	1	15.9	A	70	A	2
9	4	160.5	A	2	39	B	3	17.7	A	70.5	A	2
10	1	164.2	A	2	38	A	2	18	B	71.5	A	2
11	3	174.1	B	4	38.5	A	2	17.7	A	72.2	B	3
12	4	173.1	B	4	41	B	4	17.9	B	74	B	3
13	2	168.5	B	3	38	A	2	17.3	A	74.2	B	3
14	5	172.5	B	3	39.5	B	3	18.5	B	74.8	B	3
15	1	172.7	B	3	39	B	3	18.6	B	75.2	B	4
16	4	172.9	B	3	42	B	4	19	B	78	B	4
17	3	175.8	B	4	40	B	4	18.1	B	78.3	B	4
18	2	177.3	B	4	38	A	2	18.9	B	80	B	4
19	5	176.5	B	4	44	B	4	19.2	B	80.2	B	4
20	1	185.2	B	4	45	B	4	19	B	82	B	4

Appendix B-Qualitative Survey Questions

1. Which device did you use?
2. Under which condition did you use the device? (ask researcher if necessary)
3. Please rate your familiarity with this device prior to the study
4. Please rate the difficulty of using this device.
5. Please rate your comfort using this device
6. Please provide any feedback you have about this device.
7. Do you have any additional feedback or comments about the devices?

Appendix C - Peak %MVC EMG

	Device Means						P-values		
	Mouse		Trackpad		Rollermouse				
	Right	Center	Right	Center	Right (dummy)	Center	Device	Location	Device x Location
ECR	27.1326	27.0075	41.8600	39.0685	34.1488	35.6755	**.002**	.793	.359
TRAP	22.1623	22.0281	24.7502	26.4267	24.6184	27.7246	.157	.590	.686
Trans. ECR	.5390	.5370	.7002	.6718	.6207	.6367	**<.0001**	.794	.365
Trans. TRAP	.4690	0.4639	0.5003	0.5138	.5088	.5377	.151	.707	.829
ECR w/out outlier	24.8185	26.5926	42.0379	39.7784	33.8172	35.8584	**<.0001**	.736	.267

| | | ECR Device Means | | | | | | P-values | | | | |
| | | Mouse | | Trackpad | | Rollermouse | | | | | | |
		Right	Center	Right	Center	Right (dummy)	Center	Device	Device x group	Location	Location x group	Device x Location x group
Grouped by height	A, N=10	39.3940	30.9550	44.8430	39.6550	36.1352	33.8290	**.003**	.057	.790	.218	.490
	B, N=10	22.8712	23.0600	38.8770	38.4820	32.1624	37.5220					
Height quartiles	1, N=5	28.2760	28.7480	50.4780	39.1100	36.2744	34.7600	**.005**	.142	.726	.523	.468
	2, N=5	34.5120	33.1620	39.2080	40.2000	35.9960	32.8980					
	3, N=4	19.6900	20.1200	31.0475	28.3175	25.0975	26.3125					
	4, N=6	24.9920	25.0200	44.0957	17.15676	36.8723	44.9950					
Shoulder width quartiles	1, N=4	35.2525	29.7325	37.7800	32.2525	33.2675	31.3200	**.004**	.064	.751	.658	.511
	2, N=6	28.9667	31.0217	50.7000	46.0550	38.8543	37.5283					
	3, N=4	25.1175	29.1750	42.8475	44.8500	35.3530	34.7750					
	4, N=6	21.2287	19.7317	35.0817	32.7717	29.2280	37.3267					
Arm length	1, N=5	28.2760	28.7480	50.4780	39.1100	36.2744	34.7600	**. 004**	.235	.833	.594	.222

| | | TRAP Device Means | | | | | | P-values | | | | |
| | | Mouse | | Trackpad | | Rollermouse | | | | | | |
		Right	Center	Right	Center	Right (dummy)	Center	Device	Device x group	Location	Location x group	Device x Location x group
quartiles	2, N=5	34.5120	33.1620	39.2080	40.2000	35.9960	32.8980					
	3, N=4	18.3980	24.8183	40.5475	39. 2325	31.5510	34.6550					
	4, N=6	25.8533	21.8183	37.7633	37.9817	32.5700	39 .4333					
Grouped by height	A, N=10	26.2910	28.9230	25.3391	30.2079	27.8690	28.5839	.173	.247	.598	.686	.402
	B, N=10	18.0335	15.1331	24.1613	22.6455	21.3677	26.8652					
Height quartiles	1, N=5	23.9540	23.6420	24.2734	34.4520	25.5690	21.5238	.207	.245	.638	.975	.450
	2, N=5	28.6280	34.2040	26.4048	25.9638	30.1689	35.6440					
	3, N=4	7.4775	8.8700	15.7183	11.1725	11.2545	13.0345					
	4, N=6	25.0708	19.3085	29.7900	30.2942	28.1098	36.0857					
Shoulder width quartiles	1, N=4	32.4500	29.1175	28.0875	25.8125	28.0810	24.9375	.237	.186	.829	.259	.829
	2, N=6	22.1540	17.6615	16.4748	21.5630	20.0618	22.4555					
	3, N=4	16.6685	12.7603	30.1503	17.0090	19.4649	20.7365					

	4, N=6	18.9745	27.8468	27.2007	37.9783	30.3021	39.5103					
Arm length quartiles	1, N=5	23.9540	22.6420	24.2734	34.4520	25.5690	21.5238	.174	.252	.690	.869	.421
	2, N=5	28.6280	34.2040	26.4048	25.9638	30.1689	35.6440					
	3, N=4	17.7420	15.6910	30.4230	20.1235	21.5266	23.6535					
	4, N=6	18.2278	14.7612	19.9868	24.3268	21.2618	29.0063					

Appendix D: Anthropometry Results

Anthropometry

Pair-wise comparisons for height groups

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	cttTTRAP	2.6383	10	3.36978	1.06562
	cttSTRAP	6.3465	10	6.48309	2.05013
Pair 2	rttSTRAP	2.2700	10	1.64796	.52113
	rttTTRAP	3.1756	10	2.85195	.90187
Pair 3	ctmSTRAP	4.6289	10	4.79825	1.51734
	ctmTTRAP	1.8784	10	1.89875	.60044
Pair 4	rtmTTRAP	2.5166	10	2.86145	.90487
	rtmSTRAP	2.1940	10	1.76120	.55694
Pair 5	rtmSECR	6.7941	10	1.95206	.61730
	rtmTECR	6.8869	10	2.39770	.75822
Pair 6	ctmSECR	7.1279	10	2.39344	.75687
	ctmTECR	6.7225	10	2.59848	.82171
Pair 7	rttSECR	9.1862	10	3.56378	1.12697
	rttTECR	9.4184	10	4.47271	1.41439
Pair 8	cttSECR	8.8756	10	2.14036	.67684
	cttTECR	9.2106	10	4.16449	1.31693
Pair 9	rollSECR	8.2165	10	2.39016	.75583
	rollTECR	8.5720	10	3.25507	1.02934

Pair 10	rtmSTRAP	2.1940	10	1.76120	.55694
	rtmTTRAP	2.5166	10	2.86145	.90487
Pair 11	rollSTRAP	4.0773	10	3.02244	.95578
	rollTTRAP	4.1077	10	4.41494	1.39613

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	cttTTRAP & cttSTRAP	10	-.218	.545
Pair 2	rttSTRAP & rttTTRAP	10	.239	.507
Pair 3	ctmSTRAP & ctmTTRAP	10	.293	.412
Pair 4	rtmTTRAP & rtmSTRAP	10	-.238	.507
Pair 5	rtmSECR & rtmTECR	10	-.017	.964
Pair 6	ctmSECR & ctmTECR	10	-.011	.975
Pair 7	rttSECR & rttTECR	10	.083	.819
Pair 8	cttSECR & cttTECR	10	.278	.437
Pair 9	rollSECR & rollTECR	10	.028	.938
Pair 10	rtmSTRAP & rtmTTRAP	10	-.238	.507
Pair 11	rollSTRAP & rollTTRAP	10	.348	.324

Paired Samples Test

			Paired Differences		
					95% Confidence Interval of the Difference
		Mean	Std. Deviation	Std. Error Mean	Lower
Pair 1	cttTTRAP - cttSTRAP	-3.70816	7.93150	2.50816	-9.38201
Pair 2	rttSTRAP - rttTTRAP	-.90558	2.93379	.92775	-3.00429
Pair 3	ctmSTRAP - ctmTTRAP	2.75050	4.61463	1.45927	-.55061
Pair 4	rtmTTRAP - rtmSTRAP	.32266	3.70047	1.17019	-2.32450
Pair 5	rtmSECR - rtmTECR	-.09280	3.11680	.98562	-2.32243
Pair 6	ctmSECR - ctmTECR	.40535	3.55259	1.12343	-2.13602
Pair 7	rttSECR - rttTECR	-.23220	5.48226	1.73364	-4.15397
Pair 8	cttSECR - cttTECR	-.33500	4.11959	1.30273	-3.28197
Pair 9	rollSECR - rollTECR	-.35550	3.98345	1.25968	-3.20509
Pair 10	rtmSTRAP - rtmTTRAP	-.32266	3.70047	1.17019	-2.96982
Pair 11	rollSTRAP - rollTTRAP	-.03039	4.39727	1.39054	-3.17601

Paired Samples Test

		Paired Differences			
		95% Confidence Interval of the Difference			
		Upper	t	df	Sig. (2-tailed)
Pair 1	cttTTRAP - cttSTRAP	1.96569	-1.478	9	.173

Pair 2	rttSTRAP - rttTTRAP	1.19313	-.976	9	.355
Pair 3	ctmSTRAP - ctmTTRAP	6.05160	1.885	9	.092
Pair 4	rtmTTRAP - rtmSTRAP	2.96982	.276	9	.789
Pair 5	rtmSECR - rtmTECR	2.13683	-.094	9	.927
Pair 6	ctmSECR - ctmTECR	2.94672	.361	9	.727
Pair 7	rttSECR - rttTECR	3.68957	-.134	9	.896
Pair 8	cttSECR - cttTECR	2.61197	-.257	9	.803
Pair 9	rollSECR - rollTECR	2.49409	-.282	9	.784
Pair 10	rtmSTRAP - rtmTTRAP	2.32450	-.276	9	.789
Pair 11	rollSTRAP - rollTTRAP	3.11523	-.022	9	.983

ECR one-way ANOVA

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmECR	1.00	10	.2611	.04042	.01278	.2322
	2.00	10	.2617	.04955	.01567	.2263
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	10	.2668	.04797	.01517	.2324
	2.00	10	.2583	.05052	.01597	.2222
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	10	.3031	.06142	.01942	.2592
	2.00	10	.3048	.07549	.02387	.2508

		N	Mean	Std. Deviation	Std. Error	Lower Bound
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	10	.3006	.03809	.01204	.2734
	2.00	10	.3020	.07058	.02232	.2515
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	10	.2875	.04771	.01509	.2534
	2.00	10	.2928	.05712	.01806	.2519
	Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean	Minimum	Maximum
		Upper Bound		
TMrtmECR	1.00	.2901	.20	.31
	2.00	.2972	.18	.33
	Total	.2820	.18	.33
TMctmECR	1.00	.3011	.19	.33
	2.00	.2944	.19	.34
	Total	.2851	.19	.34
TMrttECR	1.00	.3470	.20	.40
	2.00	.3588	.20	.45
	Total	.3353	.20	.45
TMcttECR	1.00	.3279	.23	.36
	2.00	.3525	.20	.44
	Total	.3272	.20	.44

TMrollECR2	1.00	.3216	.18	.35
	2.00	.3336	.22	.40
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.000	1	.000	.001	.978
	Within Groups	.037	18	.002		
	Total	.037	19			
TMctmECR	Between Groups	.000	1	.000	.147	.705
	Within Groups	.044	18	.002		
	Total	.044	19			
TMrttECR	Between Groups	.000	1	.000	.003	.957
	Within Groups	.085	18	.005		
	Total	.085	19			
TMcttECR	Between Groups	.000	1	.000	.003	.956
	Within Groups	.058	18	.003		
	Total	.058	19			
TMrollECR2	Between Groups	.000	1	.000	.050	.825
	Within Groups	.050	18	.003		
	Total	.050	19			

ONEWAY BY heightquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmECR	1.00	5	.2742	.02837	.01269	.2390
	2.00	5	.2481	.04943	.02210	.1867
	3.00	4	.2432	.05607	.02803	.1540
	4.00	6	.2740	.04559	.01861	.2262
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	5	.2736	.05277	.02360	.2081
	2.00	5	.2599	.04771	.02134	.2007
	3.00	4	.2580	.06180	.03090	.1596
	4.00	6	.2585	.04797	.01959	.2082
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	5	.3057	.02829	.01265	.2706
	2.00	5	.3005	.08758	.03917	.1917
	3.00	4	.2534	.05722	.02861	.1623
	4.00	6	.3391	.06905	.02819	.2666
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	5	.3032	.02702	.01208	.2696
	2.00	5	.2980	.05018	.02244	.2357

	3.00	4	.2697	.06908	.03454	.1598
	4.00	6	.3236	.06862	.02801	.2516
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	5	.2955	.02227	.00996	.2679
	2.00	5	.2795	.06682	.02988	.1965
	3.00	4	.2776	.06039	.03019	.1815
	4.00	6	.3029	.05810	.02372	.2419
	Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmECR	1.00	.3095	.24	.30
	2.00	.3094	.20	.31
	3.00	.3325	.18	.30
	4.00	.3219	.20	.33
	Total	.2820	.18	.33
TMctmECR	1.00	.3391	.19	.33
	2.00	.3192	.21	.33
	3.00	.3563	.21	.34
	4.00	.3089	.19	.33
	Total	.2851	.19	.34
TMrttECR	1.00	.3409	.28	.35

	2.00	.4092	.20	.40
	3.00	.3444	.20	.32
	4.00	.4115	.24	.45
	Total	.3353	.20	.45
TMcttECR	1.00	.3367	.28	.35
	2.00	.3603	.23	.36
	3.00	.3796	.20	.34
	4.00	.3956	.25	.44
	Total	.3272	.20	.44
TMrollECR2	1.00	.3232	.27	.33
	2.00	.3625	.18	.35
	3.00	.3737	.22	.36
	4.00	.3639	.23	.40
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.004	3	.001	.648	.595
	Within Groups	.033	16	.002		
	Total	.037	19			
TMctmECR	Between Groups	.001	3	.000	.102	.958
	Within Groups	.043	16	.003		

	Total	.044	19			
TMrttECR	Between Groups	.018	3	.006	1.399	.280
	Within Groups	.068	16	.004		
	Total	.085	19			
TMcttECR	Between Groups	.007	3	.002	.739	.544
	Within Groups	.051	16	.003		
	Total	.058	19			
TMrollECR2	Between Groups	.002	3	.001	.260	.853
	Within Groups	.048	16	.003		
	Total	.050	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) heightquart	(J) heightquart	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TMrtmECR	1.00	2.00	.02617	.02864	.798	-.0558	.1081
		3.00	.03099	.03038	.740	-.0559	.1179
		4.00	.00020	.02742	1.000	-.0783	.0787
	2.00	1.00	-.02617	.02864	.798	-.1081	.0558
		3.00	.00482	.03038	.999	-.0821	.0917
		4.00	-.02597	.02742	.780	-.1044	.0525

	3.00	1.00	-.03099	.03038	.740	-.1179	.0559
		2.00	-.00482	.03038	.999	-.0917	.0821
		4.00	-.03079	.02923	.722	-.1144	.0528
	4.00	1.00	-.00020	.02742	1.000	-.0787	.0783
		2.00	.02597	.02742	.780	-.0525	.1044
		3.00	.03079	.02923	.722	-.0528	.1144
TMctmECR	1.00	2.00	.01369	.03287	.975	-.0803	.1077
		3.00	.01564	.03486	.969	-.0841	.1154
		4.00	.01508	.03147	.963	-.0749	.1051
	2.00	1.00	-.01369	.03287	.975	-.1077	.0803
		3.00	.00195	.03486	1.000	-.0978	.1017
		4.00	.00139	.03147	1.000	-.0886	.0914
	3.00	1.00	-.01564	.03486	.969	-.1154	.0841
		2.00	-.00195	.03486	1.000	-.1017	.0978
		4.00	-.00056	.03354	1.000	-.0965	.0954
	4.00	1.00	-.01508	.03147	.963	-.1051	.0749
		2.00	-.00139	.03147	1.000	-.0914	.0886
		3.00	.00056	.03354	1.000	-.0954	.0965
TMrttECR	1.00	2.00	.00526	.04109	.999	-.1123	.1228
		3.00	.05238	.04358	.634	-.0723	.1771
		4.00	-.03332	.03934	.831	-.1459	.0792
	2.00	1.00	-.00526	.04109	.999	-.1228	.1123
		3.00	.04713	.04358	.705	-.0776	.1718

		4.00	-.03858	.03934	.762	-.1511	.0740
	3.00	1.00	-.05238	.04358	.634	-.1771	.0723
		2.00	-.04713	.04358	.705	-.1718	.0776
		4.00	-.08570	.04194	.214	-.2057	.0343
	4.00	1.00	.03332	.03934	.831	-.0792	.1459
		2.00	.03858	.03934	.762	-.0740	.1511
		3.00	.08570	.04194	.214	-.0343	.2057
TMcttECR	1.00	2.00	.00516	.03566	.999	-.0969	.1072
		3.00	.03351	.03782	.812	-.0747	.1417
		4.00	-.02039	.03414	.931	-.1181	.0773
	2.00	1.00	-.00516	.03566	.999	-.1072	.0969
		3.00	.02835	.03782	.875	-.0798	.1366
		4.00	-.02555	.03414	.876	-.1232	.0721
	3.00	1.00	-.03351	.03782	.812	-.1417	.0747
		2.00	-.02835	.03782	.875	-.1366	.0798
		4.00	-.05390	.03639	.471	-.1580	.0502
	4.00	1.00	.02039	.03414	.931	-.0773	.1181
		2.00	.02555	.03414	.876	-.0721	.1232
		3.00	.05390	.03639	.471	-.0502	.1580
TMrollECR2	1.00	2.00	.01602	.03452	.966	-.0827	.1148
		3.00	.01795	.03661	.960	-.0868	.1227
		4.00	-.00740	.03305	.996	-.1020	.0872
	2.00	1.00	-.01602	.03452	.966	-.1148	.0827

	3.00	.00194	.03661	1.000	-.1028	.1067
	4.00	-.02342	.03305	.892	-.1180	.0711
3.00	1.00	-.01795	.03661	.960	-.1227	.0868
	2.00	-.00194	.03661	1.000	-.1067	.1028
	4.00	-.02535	.03523	.888	-.1261	.0754
4.00	1.00	.00740	.03305	.996	-.0872	.1020
	2.00	.02342	.03305	.892	-.0711	.1180
	3.00	.02535	.03523	.888	-.0754	.1261

Homogeneous Subsets

TMrtmECR

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
3.00	4	.2432
2.00	5	.2481
4.00	6	.2740
1.00	5	.2742
Sig.		.711

TMctmECR

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
3.00	4	.2580
4.00	6	.2585
2.00	5	.2599
1.00	5	.2736
Sig.		.964

TMrttECR

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
3.00	4	.2534
2.00	5	.3005
1.00	5	.3057
4.00	6	.3391
Sig.		.207

TMcttECR

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
3.00	4	.2697
2.00	5	.2980
1.00	5	.3032
4.00	6	.3236
Sig.		.462

TMrollECR2

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
3.00	4	.2776
2.00	5	.2795
1.00	5	.2955
4.00	6	.3029
Sig.		.885

ONEWAY shouldgroup

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmECR	1.00	10	.2672	.04954	.01567	.2317
	2.00	10	.2557	.03952	.01250	.2274
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	10	.2692	.05353	.01693	.2309
	2.00	10	.2559	.04392	.01389	.2245
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	10	.3032	.07711	.02438	.2480
	2.00	10	.3047	.05938	.01878	.2622
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	10	.3056	.06889	.02179	.2563
	2.00	10	.2970	.04058	.01283	.2680
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	10	.2871	.06131	.01939	.2432
	2.00	10	.2932	.04212	.01332	.2631
	Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmECR	1.00	.3026	.18	.33
	2.00	.2839	.20	.30
	Total	.2820	.18	.33
TMctmECR	1.00	.3075	.19	.33
	2.00	.2873	.19	.34
	Total	.2851	.19	.34
TMrttECR	1.00	.3583	.20	.45
	2.00	.3472	.21	.40
	Total	.3353	.20	.45
TMcttECR	1.00	.3549	.20	.44
	2.00	.3260	.22	.35
	Total	.3272	.20	.44
TMrollECR2	1.00	.3310	.18	.40
	2.00	.3233	.23	.36
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.001	1	.001	.330	.573
	Within Groups	.036	18	.002		
	Total	.037	19			
TMctmECR	Between Groups	.001	1	.001	.369	.551
	Within Groups	.043	18	.002		
	Total	.044	19			
TMrttECR	Between Groups	.000	1	.000	.003	.961
	Within Groups	.085	18	.005		
	Total	.085	19			
TMcttECR	Between Groups	.000	1	.000	.116	.738
	Within Groups	.058	18	.003		
	Total	.058	19			
TMrollECR2	Between Groups	.000	1	.000	.067	.799
	Within Groups	.050	18	.003		
	Total	.050	19			

ONEWAY BY shouldquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmECR	1.00	4	.2557	.04451	.02225	.1849
	2.00	6	.2748	.05526	.02256	.2168
	3.00	4	.2611	.03977	.01988	.1978
	4.00	6	.2521	.04269	.01743	.2073
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	4	.2720	.05089	.02544	.1910
	2.00	6	.2673	.05995	.02448	.2044
	3.00	4	.2808	.05154	.02577	.1987
	4.00	6	.2393	.03243	.01324	.2053
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	4	.2624	.04235	.02118	.1950
	2.00	6	.3303	.08609	.03515	.2400
	3.00	4	.3219	.08287	.04143	.1900
	4.00	6	.2933	.04283	.01748	.2483
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	4	.2762	.03437	.01719	.2215
	2.00	6	.3252	.08172	.03336	.2395
	3.00	4	.3095	.06092	.03046	.2126

	4.00	6	.2887	.02299	.00939	.2646
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	4	.2546	.05458	.02729	.1677
	2.00	6	.3088	.05971	.02438	.2461
	3.00	4	.3170	.05366	.02683	.2316
	4.00	6	.2773	.02666	.01088	.2493
	Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmECR	1.00	.3265	.20	.29
	2.00	.3328	.18	.33
	3.00	.3244	.21	.30
	4.00	.2969	.20	.29
	Total	.2820	.18	.33
TMctmECR	1.00	.3530	.21	.33
	2.00	.3302	.19	.33
	3.00	.3628	.22	.34
	4.00	.2733	.19	.28
	Total	.2851	.19	.34
TMrttECR	1.00	.3298	.20	.30
	2.00	.4207	.20	.45

	3.00	.4537	.21	.40
	4.00	.3382	.24	.35
	Total	.3353	.20	.45
TMcttECR	1.00	.3309	.23	.31
	2.00	.4110	.20	.44
	3.00	.4065	.22	.35
	4.00	.3128	.25	.31
	Total	.3272	.20	.44
TMrollECR2	1.00	.3414	.18	.30
	2.00	.3715	.22	.40
	3.00	.4024	.24	.36
	4.00	.3053	.23	.30
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.002	3	.001	.264	.851
	Within Groups	.035	16	.002		
	Total	.037	19			
TMctmECR	Between Groups	.005	3	.002	.693	.570
	Within Groups	.039	16	.002		
	Total	.044	19			

TMrttECR	Between Groups	.013	3	.004	.963	.434
	Within Groups	.072	16	.005		
	Total	.085	19			
TMcttECR	Between Groups	.007	3	.002	.756	.535
	Within Groups	.051	16	.003		
	Total	.058	19			
TMrollECR2	Between Groups	.011	3	.004	1.510	.250
	Within Groups	.039	16	.002		
	Total	.050	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) shouldquart	(J) shouldquart	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TMrtmECR	1.00	2.00	-.01911	.03022	.920	-.1056	.0674
		3.00	-.00536	.03311	.998	-.1001	.0894
		4.00	.00365	.03022	.999	-.0828	.0901
	2.00	1.00	.01911	.03022	.920	-.0674	.1056
		3.00	.01375	.03022	.968	-.0727	.1002
		4.00	.02276	.02703	.834	-.0546	.1001

	3.00	1.00	.00536	.03311	.998	-.0894	.1001
		2.00	-.01375	.03022	.968	-.1002	.0727
		4.00	.00901	.03022	.990	-.0774	.0955
	4.00	1.00	-.00365	.03022	.999	-.0901	.0828
		2.00	-.02276	.02703	.834	-.1001	.0546
		3.00	-.00901	.03022	.990	-.0955	.0774
TMctmECR	1.00	2.00	.00466	.03186	.999	-.0865	.0958
		3.00	-.00877	.03490	.994	-.1086	.0911
		4.00	.03269	.03186	.737	-.0585	.1238
	2.00	1.00	-.00466	.03186	.999	-.0958	.0865
		3.00	-.01343	.03186	.974	-.1046	.0777
		4.00	.02803	.02849	.760	-.0535	.1096
	3.00	1.00	.00877	.03490	.994	-.0911	.1086
		2.00	.01343	.03186	.974	-.0777	.1046
		4.00	.04147	.03186	.575	-.0497	.1326
	4.00	1.00	-.03269	.03186	.737	-.1238	.0585
		2.00	-.02803	.02849	.760	-.1096	.0535
		3.00	-.04147	.03186	.575	-.1326	.0497
TMrttECR	1.00	2.00	-.06790	.04337	.424	-.1920	.0562
		3.00	-.05942	.04751	.605	-.1953	.0765
		4.00	-.03086	.04337	.891	-.1549	.0932
	2.00	1.00	.06790	.04337	.424	-.0562	.1920
		3.00	.00848	.04337	.997	-.1156	.1325

		4.00	.03704	.03879	.776	-.0739	.1480
	3.00	1.00	.05942	.04751	.605	-.0765	.1953
		2.00	-.00848	.04337	.997	-.1325	.1156
		4.00	.02856	.04337	.911	-.0955	.1526
	4.00	1.00	.03086	.04337	.891	-.0932	.1549
		2.00	-.03704	.03879	.776	-.1480	.0739
		3.00	-.02856	.04337	.911	-.1526	.0955
TMcttECR	1.00	2.00	-.04907	.03634	.546	-.1530	.0549
		3.00	-.03334	.03981	.836	-.1472	.0806
		4.00	-.01250	.03634	.985	-.1165	.0915
	2.00	1.00	.04907	.03634	.546	-.0549	.1530
		3.00	.01573	.03634	.972	-.0882	.1197
		4.00	.03657	.03250	.680	-.0564	.1296
	3.00	1.00	.03334	.03981	.836	-.0806	.1472
		2.00	-.01573	.03634	.972	-.1197	.0882
		4.00	.02084	.03634	.939	-.0831	.1248
	4.00	1.00	.01250	.03634	.985	-.0915	.1165
		2.00	-.03657	.03250	.680	-.1296	.0564
		3.00	-.02084	.03634	.939	-.1248	.0831
TMrollECR2	1.00	2.00	-.05425	.03185	.354	-.1454	.0369
		3.00	-.06245	.03489	.314	-.1623	.0374
		4.00	-.02277	.03185	.890	-.1139	.0684
	2.00	1.00	.05425	.03185	.354	-.0369	.1454

	3.00	-.00820	.03185	.994	-.0993	.0829
	4.00	.03149	.02849	.691	-.0500	.1130
3.00	1.00	.06245	.03489	.314	-.0374	.1623
	2.00	.00820	.03185	.994	-.0829	.0993
	4.00	.03968	.03185	.608	-.0514	.1308
4.00	1.00	.02277	.03185	.890	-.0684	.1139
	2.00	-.03149	.02849	.691	-.1130	.0500
	3.00	-.03968	.03185	.608	-.1308	.0514

Homogeneous Subsets

TMrtmECR

Tukey HSD[a,b]

shouldquart	N	Subset for alpha = 0.05
		1
4.00	6	.2521
1.00	4	.2557
3.00	4	.2611
2.00	6	.2748
Sig.		.874

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

TMctmECR

Tukey HSD[a,b]

shouldquart	N	Subset for alpha = 0.05
		1
4.00	6	.2393
2.00	6	.2673
1.00	4	.2720
3.00	4	.2808
Sig.		.575

Means for groups in homogeneous subsets are
displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

TMrttECR

Tukey HSD[a,b]

| shouldquart | N | Subset for alpha = 0.05 |
		1
1.00	4	.2624
4.00	6	.2933
3.00	4	.3219
2.00	6	.3303
Sig.		.424

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMcttECR

Tukey HSD[a,b]

| shouldquart | N | Subset for alpha = 0.05 |
		1
1.00	4	.2762
4.00	6	.2887
3.00	4	.3095

2.00	6	.3252
Sig.		.546

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMrollECR2

Tukey HSD[a,b]

shouldquart	N	Subset for alpha = 0.05
		1
1.00	4	.2546
4.00	6	.2773
2.00	6	.3088
3.00	4	.3170
Sig.		.243

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

ONEWAY BY armgroup

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound
TMrtmECR	1.00	10	.2611	.04042	.01278	.2322
	2.00	10	.2617	.04955	.01567	.2263
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	10	.2668	.04797	.01517	.2324
	2.00	10	.2583	.05052	.01597	.2222
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	10	.3031	.06142	.01942	.2592
	2.00	10	.3048	.07549	.02387	.2508
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	10	.3006	.03809	.01204	.2734
	2.00	10	.3020	.07058	.02232	.2515
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	10	.2875	.04771	.01509	.2534

2.00	10	.2928	.05712	.01806	.2519
Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmECR	1.00	.2901	.20	.31
	2.00	.2972	.18	.33
	Total	.2820	.18	.33
TMctmECR	1.00	.3011	.19	.33
	2.00	.2944	.19	.34
	Total	.2851	.19	.34
TMrttECR	1.00	.3470	.20	.40
	2.00	.3588	.20	.45
	Total	.3353	.20	.45
TMcttECR	1.00	.3279	.23	.36
	2.00	.3525	.20	.44
	Total	.3272	.20	.44
TMrollECR2	1.00	.3216	.18	.35
	2.00	.3336	.22	.40
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.000	1	.000	.001	.978
	Within Groups	.037	18	.002		
	Total	.037	19			
TMctmECR	Between Groups	.000	1	.000	.147	.705
	Within Groups	.044	18	.002		
	Total	.044	19			
TMrttECR	Between Groups	.000	1	.000	.003	.957
	Within Groups	.085	18	.005		
	Total	.085	19			
TMcttECR	Between Groups	.000	1	.000	.003	.956
	Within Groups	.058	18	.003		
	Total	.058	19			
TMrollECR2	Between Groups	.000	1	.000	.050	.825
	Within Groups	.050	18	.003		
	Total	.050	19			

ONEWAY BY armquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean

					Lower Bound
TMrtmECR	1.00	5	.2742	.02837	.01269	.2390
	2.00	5	.2481	.04943	.02210	.1867
	3.00	5	.2442	.06620	.02961	.1620
	4.00	5	.2792	.01944	.00869	.2551
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	5	.2736	.05277	.02360	.2081
	2.00	5	.2599	.04771	.02134	.2007
	3.00	5	.2590	.07333	.03280	.1680
	4.00	5	.2576	.01903	.00851	.2339
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	5	.3057	.02829	.01265	.2706
	2.00	5	.3005	.08758	.03917	.1917
	3.00	5	.2861	.10466	.04681	.1562
	4.00	5	.3234	.03161	.01414	.2842
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	5	.3032	.02702	.01208	.2696
	2.00	5	.2980	.05018	.02244	.2357
	3.00	5	.2913	.09936	.04444	.1679
	4.00	5	.3127	.03239	.01449	.2725
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	5	.2955	.02227	.00996	.2679
	2.00	5	.2795	.06682	.02988	.1965

3.00	5	.2879	.08203	.03669	.1860
4.00	5	.2977	.02348	.01050	.2686
Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmECR	1.00	.3095	.24	.30
	2.00	.3094	.20	.31
	3.00	.3264	.18	.33
	4.00	.3033	.24	.29
	Total	.2820	.18	.33
TMctmECR	1.00	.3391	.19	.33
	2.00	.3192	.21	.33
	3.00	.3501	.19	.34
	4.00	.2812	.23	.28
	Total	.2851	.19	.34
TMrttECR	1.00	.3409	.28	.35
	2.00	.4092	.20	.40
	3.00	.4161	.20	.45
	4.00	.3627	.28	.35
	Total	.3353	.20	.45
TMcttECR	1.00	.3367	.28	.35

	2.00	.3603	.23	.36
	3.00	.4147	.20	.44
	4.00	.3530	.28	.37
	Total	.3272	.20	.44
TMrollECR2	1.00	.3232	.27	.33
	2.00	.3625	.18	.35
	3.00	.3897	.22	.40
	4.00	.3269	.27	.34
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.005	3	.002	.794	.515
	Within Groups	.032	16	.002		
	Total	.037	19			
TMctmECR	Between Groups	.001	3	.000	.103	.957
	Within Groups	.043	16	.003		
	Total	.044	19			
TMrttECR	Between Groups	.004	3	.001	.232	.873
	Within Groups	.082	16	.005		
	Total	.085	19			
TMcttECR	Between Groups	.001	3	.000	.115	.950

	Within Groups	.057	16	.004		
	Total	.058	19			
TMrollECR2	Between Groups	.001	3	.000	.111	.952
	Within Groups	.049	16	.003		
	Total	.050	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) armquart	(J) armquart	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TMrtmECR	1.00	2.00	.02617	.02830	.792	-.0548	.1071
		3.00	.02999	.02830	.718	-.0510	.1110
		4.00	-.00497	.02830	.998	-.0859	.0760
	2.00	1.00	-.02617	.02830	.792	-.1071	.0548
		3.00	.00382	.02830	.999	-.0771	.0848
		4.00	-.03114	.02830	.694	-.1121	.0498
	3.00	1.00	-.02999	.02830	.718	-.1110	.0510
		2.00	-.00382	.02830	.999	-.0848	.0771
		4.00	-.03496	.02830	.614	-.1159	.0460
	4.00	1.00	.00497	.02830	.998	-.0760	.0859
		2.00	.03114	.02830	.694	-.0498	.1121

		3.00	.03496	.02830	.614	-.0460	.1159
TMctmECR	1.00	2.00	.01369	.03286	.975	-.0803	.1077
		3.00	.01456	.03286	.970	-.0795	.1086
		4.00	.01605	.03286	.961	-.0780	.1101
	2.00	1.00	-.01369	.03286	.975	-.1077	.0803
		3.00	.00087	.03286	1.000	-.0932	.0949
		4.00	.00236	.03286	1.000	-.0917	.0964
	3.00	1.00	-.01456	.03286	.970	-.1086	.0795
		2.00	-.00087	.03286	1.000	-.0949	.0932
		4.00	.00148	.03286	1.000	-.0925	.0955
	4.00	1.00	-.01605	.03286	.961	-.1101	.0780
		2.00	-.00236	.03286	1.000	-.0964	.0917
		3.00	-.00148	.03286	1.000	-.0955	.0925
TMrttECR	1.00	2.00	.00526	.04519	.999	-.1240	.1346
		3.00	.01960	.04519	.972	-.1097	.1489
		4.00	-.01768	.04519	.979	-.1470	.1116
	2.00	1.00	-.00526	.04519	.999	-.1346	.1240
		3.00	.01434	.04519	.989	-.1150	.1436
		4.00	-.02294	.04519	.956	-.1522	.1064
	3.00	1.00	-.01960	.04519	.972	-.1489	.1097
		2.00	-.01434	.04519	.989	-.1436	.1150
		4.00	-.03728	.04519	.842	-.1666	.0920
	4.00	1.00	.01768	.04519	.979	-.1116	.1470

		2.00	.02294	.04519	.956	-.1064	.1522
		3.00	.03728	.04519	.842	-.0920	.1666
TMcttECR	1.00	2.00	.00516	.03764	.999	-.1025	.1129
		3.00	.01188	.03764	.989	-.0958	.1196
		4.00	-.00954	.03764	.994	-.1172	.0982
	2.00	1.00	-.00516	.03764	.999	-.1129	.1025
		3.00	.00672	.03764	.998	-.1010	.1144
		4.00	-.01470	.03764	.979	-.1224	.0930
	3.00	1.00	-.01188	.03764	.989	-.1196	.0958
		2.00	-.00672	.03764	.998	-.1144	.1010
		4.00	-.02142	.03764	.940	-.1291	.0863
	4.00	1.00	.00954	.03764	.994	-.0982	.1172
		2.00	.01470	.03764	.979	-.0930	.1224
		3.00	.02142	.03764	.940	-.0863	.1291
TMrollECR2	1.00	2.00	.01602	.03499	.967	-.0841	.1161
		3.00	.00766	.03499	.996	-.0924	.1078
		4.00	-.00218	.03499	1.000	-.1023	.0979
	2.00	1.00	-.01602	.03499	.967	-.1161	.0841
		3.00	-.00835	.03499	.995	-.1085	.0917
		4.00	-.01820	.03499	.953	-.1183	.0819
	3.00	1.00	-.00766	.03499	.996	-.1078	.0924
		2.00	.00835	.03499	.995	-.0917	.1085
		4.00	-.00984	.03499	.992	-.1099	.0903

4.00	1.00	.00218	.03499	1.000	-.0979	.1023
	2.00	.01820	.03499	.953	-.0819	.1183
	3.00	.00984	.03499	.992	-.0903	.1099

Homogeneous Subsets

TMrtmECR

Tukey HSD[a]

armquart	N	Subset for alpha = 0.05
		1
3.00	5	.2442
2.00	5	.2481
1.00	5	.2742
4.00	5	.2792
Sig.		.614

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

TMctmECR

Tukey HSD[a]

| armquart | N | Subset for alpha = 0.05 |
		1
4.00	5	.2576
3.00	5	.2590
2.00	5	.2599
1.00	5	.2736
Sig.		.961

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

TMrttECR

Tukey HSD[a]

| armquart | N | Subset for alpha = 0.05 |
		1
3.00	5	.2861
2.00	5	.3005
1.00	5	.3057
4.00	5	.3234
Sig.		.842

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

TMcttECR

Tukey HSD[a]

		Subset for alpha = 0.05
armquart	N	1
3.00	5	.2913
2.00	5	.2980
1.00	5	.3032
4.00	5	.3127
Sig.		.940

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

TMrollECR2

Tukey HSD[a]

armquart	N	Subset for alpha = 0.05
		1
2.00	5	.2795
3.00	5	.2879
1.00	5	.2955
4.00	5	.2977
Sig.		.953

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

ONEWAY BY handgroup

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmECR	1.00	10	.2529	.04976	.01573	.2173
	2.00	10	.2699	.03813	.01206	.2426
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	10	.2591	.05122	.01620	.2224

		N	Mean	Std. Deviation	Std. Error	Lower Bound
	2.00	10	.2660	.04735	.01497	.2321
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	10	.3004	.08169	.02583	.2420
	2.00	10	.3075	.05264	.01665	.2698
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	10	.3010	.06470	.02046	.2547
	2.00	10	.3017	.04740	.01499	.2678
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	10	.2885	.06210	.01964	.2441
	2.00	10	.2918	.04114	.01301	.2623
	Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmECR	1.00	.2885	.18	.33
	2.00	.2972	.20	.31
	Total	.2820	.18	.33
TMctmECR	1.00	.2957	.19	.33
	2.00	.2999	.19	.34
	Total	.2851	.19	.34
TMrttECR	1.00	.3588	.20	.45
	2.00	.3452	.21	.38

	Total	.3353	.20	.45
TMcttECR	1.00	.3472	.20	.44
	2.00	.3356	.22	.37
	Total	.3272	.20	.44
TMrollECR2	1.00	.3330	.18	.40
	2.00	.3212	.23	.36
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.001	1	.001	.733	.403
	Within Groups	.035	18	.002		
	Total	.037	19			
TMctmECR	Between Groups	.000	1	.000	.098	.758
	Within Groups	.044	18	.002		
	Total	.044	19			
TMrttECR	Between Groups	.000	1	.000	.053	.820
	Within Groups	.085	18	.005		
	Total	.085	19			
TMcttECR	Between Groups	.000	1	.000	.001	.978
	Within Groups	.058	18	.003		
	Total	.058	19			

TMrollECR2	Between Groups	.000	1	.000	.019	.892
	Within Groups	.050	18	.003		
	Total	.050	19			

ONEWAY BY handquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound
TMrtmECR	1.00	3	.2268	.02794	.01613	.1574
	2.00	7	.2641	.05447	.02059	.2138
	3.00	5	.2768	.04332	.01937	.2230
	4.00	5	.2630	.03572	.01597	.2187
	Total	20	.2614	.04401	.00984	.2408
TMctmECR	1.00	3	.2179	.03299	.01905	.1359
	2.00	7	.2767	.04858	.01836	.2318
	3.00	5	.2869	.05958	.02664	.2130
	4.00	5	.2450	.01991	.00891	.2203
	Total	20	.2625	.04814	.01076	.2400
TMrttECR	1.00	3	.2562	.05003	.02889	.1319
	2.00	7	.3193	.08820	.03334	.2378
	3.00	5	.3197	.05209	.02329	.2550

	4.00	5	.2953	.05614	.02511	.2256
	Total	20	.3039	.06698	.01498	.2726
TMcttECR	1.00	3	.2717	.03775	.02180	.1779
	2.00	7	.3135	.07206	.02724	.2469
	3.00	5	.3080	.04572	.02045	.2513
	4.00	5	.2953	.05351	.02393	.2289
	Total	20	.3013	.05520	.01234	.2755
TMrollECR2	1.00	3	.2366	.05227	.03018	.1067
	2.00	7	.3108	.05428	.02051	.2606
	3.00	5	.2923	.05104	.02283	.2290
	4.00	5	.2912	.03466	.01550	.2482
	Total	20	.2902	.05129	.01147	.2661

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmECR	1.00	.2962	.20	.25
	2.00	.3145	.18	.33
	3.00	.3306	.20	.31
	4.00	.3074	.21	.29
	Total	.2820	.18	.33
TMctmECR	1.00	.2998	.19	.25
	2.00	.3217	.21	.33

	3.00	.3609	.19	.34
	4.00	.2697	.22	.26
	Total	.2851	.19	.34
TMrttECR	1.00	.3805	.20	.30
	2.00	.4009	.20	.45
	3.00	.3843	.24	.38
	4.00	.3650	.21	.35
	Total	.3353	.20	.45
TMcttECR	1.00	.3655	.23	.30
	2.00	.3802	.20	.44
	3.00	.3648	.25	.36
	4.00	.3618	.22	.37
	Total	.3272	.20	.44
TMrollECR2	1.00	.3664	.18	.27
	2.00	.3610	.22	.40
	3.00	.3557	.23	.36
	4.00	.3342	.24	.34
	Total	.3142	.18	.40

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmECR	Between Groups	.005	3	.002	.807	.509
	Within Groups	.032	16	.002		
	Total	.037	19			
TMctmECR	Between Groups	.012	3	.004	1.978	.158
	Within Groups	.032	16	.002		
	Total	.044	19			
TMrttECR	Between Groups	.010	3	.003	.718	.556
	Within Groups	.075	16	.005		
	Total	.085	19			
TMcttECR	Between Groups	.004	3	.001	.404	.752
	Within Groups	.054	16	.003		
	Total	.058	19			
TMrollECR2	Between Groups	.012	3	.004	1.615	.225
	Within Groups	.038	16	.002		
	Total	.050	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) handquart	(J) handquart	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TMrtmECR	1.00	2.00	-.03730	.03085	.630	-.1256	.0510

		3.00	-.04996	.03264	.444	-.1434	.0434
		4.00	-.03620	.03264	.689	-.1296	.0572
	2.00	1.00	.03730	.03085	.630	-.0510	.1256
		3.00	-.01266	.02617	.962	-.0875	.0622
		4.00	.00110	.02617	1.000	-.0738	.0760
	3.00	1.00	.04996	.03264	.444	-.0434	.1434
		2.00	.01266	.02617	.962	-.0622	.0875
		4.00	.01376	.02827	.961	-.0671	.0946
	4.00	1.00	.03620	.03264	.689	-.0572	.1296
		2.00	-.00110	.02617	1.000	-.0760	.0738
		3.00	-.01376	.02827	.961	-.0946	.0671
TMctmECR	1.00	2.00	-.05887	.03092	.265	-.1473	.0296
		3.00	-.06907	.03272	.192	-.1627	.0245
		4.00	-.02713	.03272	.840	-.1207	.0665
	2.00	1.00	.05887	.03092	.265	-.0296	.1473
		3.00	-.01020	.02624	.979	-.0853	.0649
		4.00	.03174	.02624	.630	-.0433	.1068
	3.00	1.00	.06907	.03272	.192	-.0245	.1627
		2.00	.01020	.02624	.979	-.0649	.0853
		4.00	.04194	.02834	.471	-.0391	.1230
	4.00	1.00	.02713	.03272	.840	-.0665	.1207
		2.00	-.03174	.02624	.630	-.1068	.0433
		3.00	-.04194	.02834	.471	-.1230	.0391

TMrttECR	1.00	2.00	-.06316	.04729	.555	-.1985	.0721
		3.00	-.06348	.05005	.595	-.2067	.0797
		4.00	-.03914	.05005	.861	-.1823	.1040
	2.00	1.00	.06316	.04729	.555	-.0721	.1985
		3.00	-.00032	.04013	1.000	-.1151	.1145
		4.00	.02401	.04013	.931	-.0908	.1388
	3.00	1.00	.06348	.05005	.595	-.0797	.2067
		2.00	.00032	.04013	1.000	-.1145	.1151
		4.00	.02434	.04334	.942	-.0997	.1483
	4.00	1.00	.03914	.05005	.861	-.1040	.1823
		2.00	-.02401	.04013	.931	-.1388	.0908
		3.00	-.02434	.04334	.942	-.1483	.0997
TMcttECR	1.00	2.00	-.04180	.04002	.727	-.1563	.0727
		3.00	-.03633	.04236	.826	-.1575	.0849
		4.00	-.02360	.04236	.943	-.1448	.0976
	2.00	1.00	.04180	.04002	.727	-.0727	.1563
		3.00	.00547	.03396	.998	-.0917	.1026
		4.00	.01819	.03396	.949	-.0790	.1154
	3.00	1.00	.03633	.04236	.826	-.0849	.1575
		2.00	-.00547	.03396	.998	-.1026	.0917
		4.00	.01273	.03668	.985	-.0922	.1177
	4.00	1.00	.02360	.04236	.943	-.0976	.1448
		2.00	-.01819	.03396	.949	-.1154	.0790
		3.00	-.01273	.03668	.985	-.1177	.0922

TMrollECR2	1.00	2.00	-.07420	.03379	.167	-.1709	.0225
		3.00	-.05575	.03576	.428	-.1581	.0466
		4.00	-.05461	.03576	.445	-.1569	.0477
	2.00	1.00	.07420	.03379	.167	-.0225	.1709
		3.00	.01845	.02867	.916	-.0636	.1005
		4.00	.01959	.02867	.902	-.0624	.1016
	3.00	1.00	.05575	.03576	.428	-.0466	.1581
		2.00	-.01845	.02867	.916	-.1005	.0636
		4.00	.00114	.03097	1.000	-.0875	.0897
	4.00	1.00	.05461	.03576	.445	-.0477	.1569
		2.00	-.01959	.02867	.902	-.1016	.0624
		3.00	-.00114	.03097	1.000	-.0897	.0875

Homogeneous Subsets

TMrtmECR

Tukey HSD[a,b]

handquart	N	Subset for alpha = 0.05
		1
1.00	3	.2268
4.00	5	.2630
2.00	7	.2641
3.00	5	.2768
Sig.		.361

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
4.565.

b. The group sizes are unequal. The
harmonic mean of the group sizes is used.
Type I error levels are not guaranteed.

TMctmECR

Tukey HSD[a,b]

handquart	N	Subset for alpha = 0.05
		1
1.00	3	.2179
4.00	5	.2450
2.00	7	.2767
3.00	5	.2869
Sig.		.133

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
4.565.

b. The group sizes are unequal. The
harmonic mean of the group sizes is used.
Type I error levels are not guaranteed.

TMrttECR

Tukey HSD[a,b]

handquart	N	Subset for alpha = 0.05
		1
1.00	3	.2562
4.00	5	.2953
2.00	7	.3193
3.00	5	.3197
Sig.		.517

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.565.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMcttECR

Tukey HSD[a,b]

handquart	N	Subset for alpha = 0.05
		1
1.00	3	.2717
4.00	5	.2953

3.00	5	.3080
2.00	7	.3135
Sig.		.701

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
4.565.

b. The group sizes are unequal. The
harmonic mean of the group sizes is used.
Type I error levels are not guaranteed.

TMrollECR2

Tukey HSD[a,b]

| handquart | N | Subset for alpha = 0.05 |
		1
1.00	3	.2366
4.00	5	.2912
3.00	5	.2923
2.00	7	.3108
Sig.		.142

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
4.565.

b. The group sizes are unequal. The
harmonic mean of the group sizes is used.
Type I error levels are not guaranteed.

TRAP one way ANOVA

ONEWAY BY group

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmTRAP2	1.00	10	.1392	.05600	.01771	.0991
	2.00	10	.1366	.08806	.02785	.0736
	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	10	.1955	.10303	.03258	.1218
	2.00	10	.1245	.06244	.01975	.0799
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	10	.1432	.05229	.01654	.1058
	2.00	10	.1587	.08917	.02820	.0950
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	10	.2247	.13247	.04189	.1300
	2.00	10	.1395	.09142	.02891	.0741
	Total	20	.1821	.11909	.02663	.1264

TMrollTRAP2	1.00	10	.1864	.08753	.02768	.1238
	2.00	10	.1801	.10459	.03308	.1053
	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.1793	.08	.23
	2.00	.1996	.05	.30
	Total	.1715	.05	.30
TMctmTRAP2	1.00	.2693	.08	.40
	2.00	.1692	.06	.25
	Total	.2024	.06	.40
TMrttTRAP2	1.00	.1806	.09	.24
	2.00	.2225	.06	.27
	Total	.1845	.06	.27
TMcttTRAP2	1.00	.3195	.08	.44
	2.00	.2049	.05	.34
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.2490	.06	.28
	2.00	.2550	.08	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.000	1	.000	.006	.938
	Within Groups	.098	18	.005		
	Total	.098	19			
TMctmTRAP2	Between Groups	.025	1	.025	3.475	.079
	Within Groups	.131	18	.007		
	Total	.156	19			
TMrttTRAP2	Between Groups	.001	1	.001	.227	.640
	Within Groups	.096	18	.005		
	Total	.097	19			
TMcttTRAP2	Between Groups	.036	1	.036	2.804	.111
	Within Groups	.233	18	.013		
	Total	.269	19			
TMrollTRAP2	Between Groups	.000	1	.000	.021	.886
	Within Groups	.167	18	.009		
	Total	.168	19			

ONEWAY BY heightquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmTRAP2	1.00	5	.1380	.06594	.02949	.0561
	2.00	5	.1404	.05200	.02326	.0758
	3.00	4	.0672	.01854	.00927	.0377
	4.00	6	.1829	.08565	.03497	.0930
	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	5	.1770	.09950	.04450	.0535
	2.00	5	.2141	.11456	.05123	.0718
	3.00	4	.1307	.06896	.03448	.0209
	4.00	6	.1204	.06414	.02619	.0531
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	5	.1310	.03757	.01680	.0844
	2.00	5	.1553	.06613	.02957	.0732
	3.00	4	.0749	.01485	.00742	.0512
	4.00	6	.2147	.06925	.02827	.1420
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	5	.2146	.14020	.06270	.0405
	2.00	5	.2348	.13989	.06256	.0611
	3.00	4	.0686	.01334	.00667	.0474
	4.00	6	.1868	.09072	.03704	.0916
	Total	20	.1821	.11909	.02663	.1264

TMrollTRAP2	1.00	5	.1407	.08714	.03897	.0325
	2.00	5	.2320	.06663	.02980	.1493
	3.00	4	.0943	.01470	.00735	.0709
	4.00	6	.2373	.09872	.04030	.1337
	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.2199	.08	.22
	2.00	.2050	.11	.23
	3.00	.0967	.05	.09
	4.00	.2727	.07	.30
	Total	.1715	.05	.30
TMctmTRAP2	1.00	.3006	.08	.34
	2.00	.3563	.12	.40
	3.00	.2404	.06	.21
	4.00	.1878	.08	.25
	Total	.2024	.06	.40
TMrttTRAP2	1.00	.1777	.09	.18
	2.00	.2374	.09	.24
	3.00	.0985	.06	.09
	4.00	.2873	.08	.27

	Total	.1845	.06	.27
TMcttTRAP2	1.00	.3887	.08	.40
	2.00	.4086	.12	.44
	3.00	.0898	.05	.08
	4.00	.2820	.09	.34
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.2490	.06	.27
	2.00	.3147	.12	.28
	3.00	.1177	.08	.11
	4.00	.3409	.13	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.032	3	.011	2.599	.088
	Within Groups	.066	16	.004		
	Total	.098	19			
TMctmTRAP2	Between Groups	.029	3	.010	1.214	.337
	Within Groups	.127	16	.008		
	Total	.156	19			
TMrttTRAP2	Between Groups	.050	3	.017	5.538	.008
	Within Groups	.048	16	.003		

	Total		.097	19			
TMcttTRAP2	Between Groups		.071	3	.024	1.903	.170
	Within Groups		.199	16	.012		
	Total		.269	19			
TMrollTRAP2	Between Groups		.070	3	.023	3.834	.030
	Within Groups		.098	16	.006		
	Total		.168	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) heightquart	(J) heightquart	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TMrtmTRAP2	1.00	2.00	-.00244	.04060	1.000	-.1186	.1137
		3.00	.07074	.04306	.384	-.0525	.1939
		4.00	-.04487	.03887	.663	-.1561	.0663
	2.00	1.00	.00244	.04060	1.000	-.1137	.1186
		3.00	.07318	.04306	.356	-.0500	.1964
		4.00	-.04243	.03887	.699	-.1536	.0688
	3.00	1.00	-.07074	.04306	.384	-.1939	.0525
		2.00	-.07318	.04306	.356	-.1964	.0500
		4.00	-.11561	.04143	.057	-.2341	.0029

	4.00	1.00	.04487	.03887	.663	-.0663	.1561
		2.00	.04243	.03887	.699	-.0688	.1536
		3.00	.11561	.04143	.057	-.0029	.2341
TMctmTRAP2	1.00	2.00	-.03707	.05633	.911	-.1982	.1241
		3.00	.04636	.05975	.864	-.1246	.2173
		4.00	.05657	.05394	.724	-.0977	.2109
	2.00	1.00	.03707	.05633	.911	-.1241	.1982
		3.00	.08343	.05975	.519	-.0875	.2544
		4.00	.09364	.05394	.338	-.0607	.2480
	3.00	1.00	-.04636	.05975	.864	-.2173	.1246
		2.00	-.08343	.05975	.519	-.2544	.0875
		4.00	.01021	.05750	.998	-.1543	.1747
	4.00	1.00	-.05657	.05394	.724	-.2109	.0977
		2.00	-.09364	.05394	.338	-.2480	.0607
		3.00	-.01021	.05750	.998	-.1747	.1543
TMrttTRAP2	1.00	2.00	-.02426	.03456	.895	-.1231	.0746
		3.00	.05619	.03666	.442	-.0487	.1611
		4.00	-.08363	.03309	.093	-.1783	.0110
	2.00	1.00	.02426	.03456	.895	-.0746	.1231
		3.00	.08045	.03666	.167	-.0244	.1853
		4.00	-.05937	.03309	.312	-.1540	.0353
	3.00	1.00	-.05619	.03666	.442	-.1611	.0487
		2.00	-.08045	.03666	.167	-.1853	.0244

		4.00	-.13982*	.03527	.006	-.2407	-.0389
	4.00	1.00	.08363	.03309	.093	-.0110	.1783
		2.00	.05937	.03309	.312	-.0353	.1540
		3.00	.13982*	.03527	.006	.0389	.2407
TMcttTRAP2	1.00	2.00	-.02023	.07046	.991	-.2218	.1814
		3.00	.14604	.07473	.246	-.0678	.3599
		4.00	.02783	.06746	.976	-.1652	.2208
	2.00	1.00	.02023	.07046	.991	-.1814	.2218
		3.00	.16627	.07473	.159	-.0476	.3801
		4.00	.04805	.06746	.891	-.1450	.2411
	3.00	1.00	-.14604	.07473	.246	-.3599	.0678
		2.00	-.16627	.07473	.159	-.3801	.0476
		4.00	-.11821	.07191	.384	-.3240	.0875
	4.00	1.00	-.02783	.06746	.976	-.2208	.1652
		2.00	-.04805	.06746	.891	-.2411	.1450
		3.00	.11821	.07191	.384	-.0875	.3240
TMrollTRAP2	1.00	2.00	-.09126	.04937	.288	-.2325	.0500
		3.00	.04643	.05237	.812	-.1034	.1963
		4.00	-.09659	.04727	.214	-.2318	.0387
	2.00	1.00	.09126	.04937	.288	-.0500	.2325
		3.00	.13769	.05237	.077	-.0121	.2875
		4.00	-.00533	.04727	.999	-.1406	.1299
	3.00	1.00	-.04643	.05237	.812	-.1963	.1034

	2.00	-.13769	.05237	.077	-.2875	.0121
	4.00	-.14302	.05039	.052	-.2872	.0012
4.00	1.00	.09659	.04727	.214	-.0387	.2318
	2.00	.00533	.04727	.999	-.1299	.1406
	3.00	.14302	.05039	.052	-.0012	.2872

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

TMrtmTRAP2

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
3.00	4	.0672
1.00	5	.1380
2.00	5	.1404
4.00	6	.1829
Sig.		.054

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size = 4.898.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

TMctmTRAP2

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
4.00	6	.1204
3.00	4	.1307
1.00	5	.1770
2.00	5	.2141
Sig.		.383

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size = 4.898.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

TMrttTRAP2

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05	
		1	2
3.00	4	.0749	
1.00	5	.1310	.1310
2.00	5	.1553	.1553
4.00	6		.2147
Sig.		.139	.118

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.898.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMcttTRAP2

Tukey HSD[a,b]

heightquart	N	Subset for alpha = 0.05
		1
3.00	4	.0686
4.00	6	.1868

1.00	5	.2146
2.00	5	.2348
Sig.		.131

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size = 4.898.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

TMrollTRAP2

Tukey HSD[a,b]

		Subset for alpha = 0.05	
heightquart	N	1	2
3.00	4	.0943	
1.00	5	.1407	.1407
2.00	5	.2320	.2320
4.00	6		.2373
Sig.		.061	.253

Means for groups in homogeneous subsets are
displayed.

a. Uses Harmonic Mean Sample Size = 4.898.

b. The group sizes are unequal. The harmonic mean of
the group sizes is used. Type I error levels are not
guaranteed.

ONEWAY BY shouldgroup

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmTRAP2	1.00	10	.1585	.07891	.02495	.1021
	2.00	10	.1173	.06101	.01929	.0736
	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	10	.1686	.08299	.02624	.1092
	2.00	10	.1515	.10132	.03204	.0790
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	10	.1650	.06778	.02143	.1165
	2.00	10	.1369	.07608	.02406	.0825
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	10	.1872	.11530	.03646	.1048
	2.00	10	.1770	.12880	.04073	.0849
	Total	20	.1821	.11909	.02663	.1264
TMrollTRAP2	1.00	10	.1711	.09369	.02963	.1041
	2.00	10	.1954	.09755	.03085	.1256

	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.2150	.06	.30
	2.00	.1609	.05	.23
	Total	.1715	.05	.30
TMctmTRAP2	1.00	.2280	.08	.34
	2.00	.2240	.06	.40
	Total	.2024	.06	.40
TMrttTRAP2	1.00	.2135	.07	.26
	2.00	.1914	.06	.27
	Total	.1845	.06	.27
TMcttTRAP2	1.00	.2697	.07	.40
	2.00	.2691	.05	.44
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.2381	.06	.31
	2.00	.2652	.08	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.008	1	.008	1.708	.208
	Within Groups	.090	18	.005		
	Total	.098	19			
TMctmTRAP2	Between Groups	.001	1	.001	.170	.685
	Within Groups	.154	18	.009		
	Total	.156	19			
TMrttTRAP2	Between Groups	.004	1	.004	.757	.396
	Within Groups	.093	18	.005		
	Total	.097	19			
TMcttTRAP2	Between Groups	.001	1	.001	.035	.854
	Within Groups	.269	18	.015		
	Total	.269	19			
TMrollTRAP2	Between Groups	.003	1	.003	.324	.576
	Within Groups	.165	18	.009		
	Total	.168	19			

ONEWAY BY shouldquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmTRAP2	1.00	4	.1285	.07093	.03547	.0157
	2.00	6	.1785	.08362	.03414	.0908
	3.00	4	.0964	.02574	.01287	.0555
	4.00	6	.1312	.07564	.03088	.0518
	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	4	.2351	.08341	.04171	.1024
	2.00	6	.1242	.04815	.01966	.0737
	3.00	4	.1316	.03406	.01703	.0774
	4.00	6	.1648	.13136	.05363	.0269
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	4	.1604	.07626	.03813	.0391
	2.00	6	.1680	.06894	.02815	.0957
	3.00	4	.0889	.02899	.01450	.0428
	4.00	6	.1690	.08270	.03376	.0822
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	4	.2958	.10760	.05380	.1246
	2.00	6	.1149	.03569	.01457	.0774
	3.00	4	.1025	.03674	.01837	.0441
	4.00	6	.2267	.14715	.06007	.0722

Total		20	.1821	.11909	.02663	.1264
TMrollTRAP2	1.00	4	.2202	.09326	.04663	.0718
	2.00	6	.1383	.08578	.03502	.0483
	3.00	4	.1445	.07406	.03703	.0267
	4.00	6	.2294	.10190	.04160	.1224
	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.2414	.08	.23
	2.00	.2663	.06	.30
	3.00	.1374	.06	.13
	4.00	.2106	.05	.23
	Total	.1715	.05	.30
TMctmTRAP2	1.00	.3679	.16	.34
	2.00	.1747	.08	.21
	3.00	.1858	.08	.17
	4.00	.3026	.06	.40
	Total	.2024	.06	.40
TMrttTRAP2	1.00	.2818	.09	.24
	2.00	.2404	.07	.26
	3.00	.1350	.06	.13

	4.00	.2557	.08	.27
	Total	.1845	.06	.27
TMcttTRAP2	1.00	.4670	.14	.40
	2.00	.1523	.07	.16
	3.00	.1610	.07	.15
	4.00	.3811	.05	.44
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.3686	.08	.27
	2.00	.2283	.06	.31
	3.00	.2624	.08	.23
	4.00	.3363	.10	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.017	3	.006	1.150	.359
	Within Groups	.081	16	.005		
	Total	.098	19			
TMctmTRAP2	Between Groups	.034	3	.011	1.468	.261
	Within Groups	.122	16	.008		
	Total	.156	19			
TMrttTRAP2	Between Groups	.019	3	.006	1.331	.299

	Within Groups	.078	16	.005		
	Total	.097	19			
TMcttTRAP2	Between Groups	.116	3	.039	4.034	.026
	Within Groups	.153	16	.010		
	Total	.269	19			
TMrollTRAP2	Between Groups	.036	3	.012	1.477	.258
	Within Groups	.131	16	.008		
	Total	.168	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

						95% Confidence Interval	
Dependent Variable	(I) shouldquart	(J) shouldquart	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
TMrtmTRAP2	1.00	2.00	-.04997	.04583	.700	-.1811	.0811
		3.00	.03212	.05020	.918	-.1115	.1757
		4.00	-.00267	.04583	1.000	-.1338	.1284
	2.00	1.00	.04997	.04583	.700	-.0811	.1811
		3.00	.08209	.04583	.313	-.0490	.2132
		4.00	.04730	.04099	.663	-.0700	.1646
	3.00	1.00	-.03212	.05020	.918	-.1757	.1115
		2.00	-.08209	.04583	.313	-.2132	.0490

		4.00	-.03479	.04583	.871	-.1659	.0963
	4.00	1.00	.00267	.04583	1.000	-.1284	.1338
		2.00	-.04730	.04099	.663	-.1646	.0700
		3.00	.03479	.04583	.871	-.0963	.1659
TMctmTRAP2	1.00	2.00	.11091	.05642	.241	-.0505	.2723
		3.00	.10356	.06180	.368	-.0732	.2804
		4.00	.07037	.05642	.607	-.0910	.2318
	2.00	1.00	-.11091	.05642	.241	-.2723	.0505
		3.00	-.00735	.05642	.999	-.1688	.1541
		4.00	-.04054	.05046	.852	-.1849	.1038
	3.00	1.00	-.10356	.06180	.368	-.2804	.0732
		2.00	.00735	.05642	.999	-.1541	.1688
		4.00	-.03319	.05642	.934	-.1946	.1282
	4.00	1.00	-.07037	.05642	.607	-.2318	.0910
		2.00	.04054	.05046	.852	-.1038	.1849
		3.00	.03319	.05642	.934	-.1282	.1946
TMrttTRAP2	1.00	2.00	-.00760	.04505	.998	-.1365	.1213
		3.00	.07151	.04935	.489	-.0697	.2127
		4.00	-.00853	.04505	.997	-.1374	.1204
	2.00	1.00	.00760	.04505	.998	-.1213	.1365
		3.00	.07911	.04505	.329	-.0498	.2080
		4.00	-.00094	.04029	1.000	-.1162	.1143
	3.00	1.00	-.07151	.04935	.489	-.2127	.0697

		2.00	-.07911	.04505	.329	-.2080	.0498
		4.00	-.08004	.04505	.320	-.2089	.0488
	4.00	1.00	.00853	.04505	.997	-.1204	.1374
		2.00	.00094	.04029	1.000	-.1143	.1162
		3.00	.08004	.04505	.320	-.0488	.2089
TMcttTRAP2	1.00	2.00	.18090*	.06321	.050	.0001	.3617
		3.00	.19325	.06924	.057	-.0049	.3914
		4.00	.06912	.06321	.698	-.1117	.2500
	2.00	1.00	-.18090*	.06321	.050	-.3617	-.0001
		3.00	.01235	.06321	.997	-.1685	.1932
		4.00	-.11178	.05654	.237	-.2735	.0500
	3.00	1.00	-.19325	.06924	.057	-.3914	.0049
		2.00	-.01235	.06321	.997	-.1932	.1685
		4.00	-.12413	.06321	.242	-.3050	.0567
	4.00	1.00	-.06912	.06321	.698	-.2500	.1117
		2.00	.11178	.05654	.237	-.0500	.2735
		3.00	.12413	.06321	.242	-.0567	.3050
TMrollTRAP2	1.00	2.00	.08193	.05846	.516	-.0853	.2492
		3.00	.07571	.06404	.646	-.1075	.2589
		4.00	-.00914	.05846	.999	-.1764	.1581
	2.00	1.00	-.08193	.05846	.516	-.2492	.0853
		3.00	-.00622	.05846	1.000	-.1735	.1610
		4.00	-.09108	.05229	.336	-.2407	.0585

3.00	1.00	-.07571	.06404	.646	-.2589	.1075
	2.00	.00622	.05846	1.000	-.1610	.1735
	4.00	-.08485	.05846	.488	-.2521	.0824
4.00	1.00	.00914	.05846	.999	-.1581	.1764
	2.00	.09108	.05229	.336	-.0585	.2407
	3.00	.08485	.05846	.488	-.0824	.2521

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

TMrtmTRAP2

Tukey HSD[a,b]

shouldquart	N	Subset for alpha = 0.05
		1
3.00	4	.0964
1.00	4	.1285
4.00	6	.1312
2.00	6	.1785
Sig.		.313

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

TMctmTRAP2

Tukey HSD[a,b]

shouldquart	N	Subset for alpha = 0.05
		1
2.00	6	.1242
3.00	4	.1316
4.00	6	.1648
1.00	4	.2351
Sig.		.241

Means for groups in homogeneous subsets are
displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic
mean of the group sizes is used. Type I error
levels are not guaranteed.

TMrttTRAP2

Tukey HSD[a,b]

| shouldquart | N | Subset for alpha = 0.05 |
		1
3.00	4	.0889
1.00	4	.1604
2.00	6	.1680
4.00	6	.1690
Sig.		.320

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMcttTRAP2

Tukey HSD[a,b]

| shouldquart | N | Subset for alpha = 0.05 | |
		1	2
3.00	4	.1025	
2.00	6	.1149	
4.00	6	.2267	.2267
1.00	4		.2958
Sig.		.242	.698

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMrollTRAP2

Tukey HSD[a,b]

shouldquart	N	Subset for alpha = 0.05
		1
2.00	6	.1383
3.00	4	.1445
1.00	4	.2202
4.00	6	.2294
Sig.		.429

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.800.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

ONEWAY BY armgroup

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmTRAP2	1.00	10	.1392	.05600	.01771	.0991
	2.00	10	.1366	.08806	.02785	.0736
	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	10	.1955	.10303	.03258	.1218
	2.00	10	.1245	.06244	.01975	.0799
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	10	.1432	.05229	.01654	.1058
	2.00	10	.1587	.08917	.02820	.0950
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	10	.2247	.13247	.04189	.1300
	2.00	10	.1395	.09142	.02891	.0741
	Total	20	.1821	.11909	.02663	.1264
TMrollTRAP2	1.00	10	.1864	.08753	.02768	.1238
	2.00	10	.1801	.10459	.03308	.1053
	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.1793	.08	.23
	2.00	.1996	.05	.30
	Total	.1715	.05	.30
TMctmTRAP2	1.00	.2693	.08	.40
	2.00	.1692	.06	.25
	Total	.2024	.06	.40
TMrttTRAP2	1.00	.1806	.09	.24
	2.00	.2225	.06	.27
	Total	.1845	.06	.27
TMcttTRAP2	1.00	.3195	.08	.44
	2.00	.2049	.05	.34
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.2490	.06	.28
	2.00	.2550	.08	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.000	1	.000	.006	.938
	Within Groups	.098	18	.005		
	Total	.098	19			
TMctmTRAP2	Between Groups	.025	1	.025	3.475	.079
	Within Groups	.131	18	.007		
	Total	.156	19			
TMrttTRAP2	Between Groups	.001	1	.001	.227	.640
	Within Groups	.096	18	.005		
	Total	.097	19			
TMcttTRAP2	Between Groups	.036	1	.036	2.804	.111
	Within Groups	.233	18	.013		
	Total	.269	19			
TMrollTRAP2	Between Groups	.000	1	.000	.021	.886
	Within Groups	.167	18	.009		
	Total	.168	19			

ONEWAY BY armquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmTRAP2	1.00	5	.1380	.06594	.02949	.0561
	2.00	5	.1404	.05200	.02326	.0758
	3.00	5	.1230	.07133	.03190	.0344
	4.00	5	.1503	.10905	.04877	.0149
	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	5	.1770	.09950	.04450	.0535
	2.00	5	.2141	.11456	.05123	.0718
	3.00	5	.1637	.06765	.03025	.0797
	4.00	5	.0854	.01912	.00855	.0616
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	5	.1310	.03757	.01680	.0844
	2.00	5	.1553	.06613	.02957	.0732
	3.00	5	.1440	.10179	.04552	.0176
	4.00	5	.1735	.08358	.03738	.0697
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	5	.2146	.14020	.06270	.0405
	2.00	5	.2348	.13989	.06256	.0611
	3.00	5	.1122	.05522	.02469	.0436

	4.00	5	.1668	.11785	.05271	.0205
	Total	20	.1821	.11909	.02663	.1264
TMrollTRAP2	1.00	5	.1407	.08714	.03897	.0325
	2.00	5	.2320	.06663	.02980	.1493
	3.00	5	.1397	.08945	.04000	.0286
	4.00	5	.2206	.11190	.05004	.0816
	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.2199	.08	.22
	2.00	.2050	.11	.23
	3.00	.2115	.06	.22
	4.00	.2857	.05	.30
	Total	.1715	.05	.30
TMctmTRAP2	1.00	.3006	.08	.34
	2.00	.3563	.12	.40
	3.00	.2477	.08	.25
	4.00	.1091	.06	.12
	Total	.2024	.06	.40
TMrttTRAP2	1.00	.1777	.09	.18
	2.00	.2374	.09	.24

	3.00	.2704	.06	.26
	4.00	.2773	.08	.27
	Total	.1845	.06	.27
TMcttTRAP2	1.00	.3887	.08	.40
	2.00	.4086	.12	.44
	3.00	.1807	.07	.19
	4.00	.3132	.05	.34
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.2490	.06	.27
	2.00	.3147	.12	.28
	3.00	.2507	.08	.30
	4.00	.3595	.10	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.002	3	.001	.106	.955
	Within Groups	.096	16	.006		
	Total	.098	19			
TMctmTRAP2	Between Groups	.044	3	.015	2.097	.141
	Within Groups	.112	16	.007		
	Total	.156	19			

TMrttTRAP2	Between Groups	.005	3	.002	.280	.839
	Within Groups	.093	16	.006		
	Total	.097	19			
TMcttTRAP2	Between Groups	.045	3	.015	1.064	.392
	Within Groups	.225	16	.014		
	Total	.269	19			
TMrollTRAP2	Between Groups	.037	3	.012	1.531	.245
	Within Groups	.130	16	.008		
	Total	.168	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) armquart	(J) armquart	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TMrtmTRAP2	1.00	2.00	-.00244	.04902	1.000	-.1427	.1378
		3.00	.01503	.04902	.990	-.1252	.1553
		4.00	-.01229	.04902	.994	-.1525	.1280
	2.00	1.00	.00244	.04902	1.000	-.1378	.1427
		3.00	.01747	.04902	.984	-.1228	.1577
		4.00	-.00984	.04902	.997	-.1501	.1304
	3.00	1.00	-.01503	.04902	.990	-.1553	.1252

		2.00	-.01747	.04902	.984	-.1577	.1228
		4.00	-.02731	.04902	.943	-.1676	.1129
	4.00	1.00	.01229	.04902	.994	-.1280	.1525
		2.00	.00984	.04902	.997	-.1304	.1501
		3.00	.02731	.04902	.943	-.1129	.1676
TMctmTRAP2	1.00	2.00	-.03707	.05288	.895	-.1884	.1142
		3.00	.01335	.05288	.994	-.1380	.1646
		4.00	.09163	.05288	.340	-.0597	.2429
	2.00	1.00	.03707	.05288	.895	-.1142	.1884
		3.00	.05041	.05288	.777	-.1009	.2017
		4.00	.12870	.05288	.110	-.0226	.2800
	3.00	1.00	-.01335	.05288	.994	-.1646	.1380
		2.00	-.05041	.05288	.777	-.2017	.1009
		4.00	.07829	.05288	.471	-.0730	.2296
	4.00	1.00	-.09163	.05288	.340	-.2429	.0597
		2.00	-.12870	.05288	.110	-.2800	.0226
		3.00	-.07829	.05288	.471	-.2296	.0730
TMrttTRAP2	1.00	2.00	-.02426	.04809	.957	-.1619	.1133
		3.00	-.01296	.04809	.993	-.1506	.1246
		4.00	-.04245	.04809	.814	-.1801	.0951
	2.00	1.00	.02426	.04809	.957	-.1133	.1619
		3.00	.01131	.04809	.995	-.1263	.1489
		4.00	-.01819	.04809	.981	-.1558	.1194

	3.00	1.00	.01296	.04809	.993	-.1246	.1506
		2.00	-.01131	.04809	.995	-.1489	.1263
		4.00	-.02950	.04809	.926	-.1671	.1081
	4.00	1.00	.04245	.04809	.814	-.0951	.1801
		2.00	.01819	.04809	.981	-.1194	.1558
		3.00	.02950	.04809	.926	-.1081	.1671
TMcttTRAP2	1.00	2.00	-.02023	.07494	.993	-.2346	.1942
		3.00	.10244	.07494	.537	-.1120	.3168
		4.00	.04778	.07494	.918	-.1666	.2622
	2.00	1.00	.02023	.07494	.993	-.1942	.2346
		3.00	.12266	.07494	.387	-.0917	.3371
		4.00	.06801	.07494	.801	-.1464	.2824
	3.00	1.00	-.10244	.07494	.537	-.3168	.1120
		2.00	-.12266	.07494	.387	-.3371	.0917
		4.00	-.05465	.07494	.884	-.2691	.1598
	4.00	1.00	-.04778	.07494	.918	-.2622	.1666
		2.00	-.06801	.07494	.801	-.2824	.1464
		3.00	.05465	.07494	.884	-.1598	.2691
TMrollTRAP2	1.00	2.00	-.09126	.05706	.407	-.2545	.0720
		3.00	.00108	.05706	1.000	-.1622	.1643
		4.00	-.07984	.05706	.518	-.2431	.0834
	2.00	1.00	.09126	.05706	.407	-.0720	.2545
		3.00	.09233	.05706	.397	-.0709	.2556

	4.00	.01142	.05706	.997	-.1518	.1747
3.00	1.00	-.00108	.05706	1.000	-.1643	.1622
	2.00	-.09233	.05706	.397	-.2556	.0709
	4.00	-.08092	.05706	.507	-.2442	.0823
4.00	1.00	.07984	.05706	.518	-.0834	.2431
	2.00	-.01142	.05706	.997	-.1747	.1518
	3.00	.08092	.05706	.507	-.0823	.2442

Homogeneous Subsets

TMrtmTRAP2

Tukey HSD[a]

armquart	N	Subset for alpha = 0.05
		1
3.00	5	.1230
1.00	5	.1380
2.00	5	.1404
4.00	5	.1503
Sig.		.943

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

TMctmTRAP2

Tukey HSD[a]

		Subset for alpha = 0.05
armquart	N	1
4.00	5	.0854
3.00	5	.1637
1.00	5	.1770
2.00	5	.2141
Sig.		.110

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

TMrttTRAP2

Tukey HSD[a]

		Subset for alpha = 0.05
armquart	N	1
1.00	5	.1310
3.00	5	.1440

	5	.1553
2.00	5	.1553
4.00	5	.1735
Sig.		.814

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

TMcttTRAP2

Tukey HSD[a]

		Subset for alpha = 0.05
armquart	N	1
3.00	5	.1122
4.00	5	.1668
1.00	5	.2146
2.00	5	.2348
Sig.		.387

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

TMrollTRAP2

Tukey HSD[a]

armquart	N	Subset for alpha = 0.05
		1
3.00	5	.1397
1.00	5	.1407
4.00	5	.2206
2.00	5	.2320
Sig.		.397

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
5.000.

ONEWAY BY handgroup

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean
						Lower Bound
TMrtmTRAP2	1.00	10	.1442	.05954	.01883	.1016
	2.00	10	.1317	.08522	.02695	.0707

	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	10	.1978	.10363	.03277	.1236
	2.00	10	.1223	.05842	.01847	.0805
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	10	.1551	.06572	.02078	.1080
	2.00	10	.1469	.08040	.02542	.0893
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	10	.1945	.12419	.03927	.1057
	2.00	10	.1697	.11906	.03765	.0845
	Total	20	.1821	.11909	.02663	.1264
TMrollTRAP2	1.00	10	.1903	.08313	.02629	.1308
	2.00	10	.1762	.10771	.03406	.0991
	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.1867	.06	.23
	2.00	.1926	.05	.30
	Total	.1715	.05	.30
TMctmTRAP2	1.00	.2719	.08	.40
	2.00	.1641	.06	.25
	Total	.2024	.06	.40

TMrttTRAP2	1.00	.2021	.07	.26
	2.00	.2044	.06	.27
	Total	.1845	.06	.27
TMcttTRAP2	1.00	.2834	.07	.44
	2.00	.2549	.05	.40
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.2498	.06	.28
	2.00	.2533	.08	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.001	1	.001	.144	.708
	Within Groups	.097	18	.005		
	Total	.098	19			
TMctmTRAP2	Between Groups	.028	1	.028	4.025	.060
	Within Groups	.127	18	.007		
	Total	.156	19			
TMrttTRAP2	Between Groups	.000	1	.000	.062	.806
	Within Groups	.097	18	.005		
	Total	.097	19			
TMcttTRAP2	Between Groups	.003	1	.003	.209	.653

	Within Groups	.266	18	.015		
	Total	.269	19			
TMrollTRAP2	Between Groups	.001	1	.001	.107	.747
	Within Groups	.167	18	.009		
	Total	.168	19			

ONEWAY BY handquart

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound
TMrtmTRAP2	1.00	3	.1801	.06163	.03558	.0270
	2.00	7	.1288	.05595	.02115	.0770
	3.00	5	.1089	.06215	.02780	.0317
	4.00	5	.1544	.10576	.04730	.0231
	Total	20	.1379	.07184	.01606	.1043
TMctmTRAP2	1.00	3	.1659	.08801	.05081	-.0527
	2.00	7	.2114	.11314	.04276	.1068
	3.00	5	.1590	.06280	.02808	.0810
	4.00	5	.0856	.01910	.00854	.0619
	Total	20	.1600	.09057	.02025	.1176
TMrttTRAP2	1.00	3	.2051	.03774	.02179	.1114

		N	Mean	Std. Deviation	Std. Error	Lower Bound
	2.00	7	.1336	.06490	.02453	.0736
	3.00	5	.1201	.07616	.03406	.0255
	4.00	5	.1737	.08334	.03727	.0702
	Total	20	.1510	.07159	.01601	.1175
TMcttTRAP2	1.00	3	.2073	.09381	.05416	-.0258
	2.00	7	.1891	.14172	.05357	.0580
	3.00	5	.2037	.12628	.05648	.0469
	4.00	5	.1356	.11422	.05108	-.0062
	Total	20	.1821	.11909	.02663	.1264
TMrollTRAP2	1.00	3	.2117	.09240	.05335	-.0178
	2.00	7	.1811	.08481	.03206	.1027
	3.00	5	.1469	.08942	.03999	.0359
	4.00	5	.2055	.12636	.05651	.0486
	Total	20	.1833	.09392	.02100	.1393

Descriptives

		95% Confidence Interval for Mean		
		Upper Bound	Minimum	Maximum
TMrtmTRAP2	1.00	.3332	.11	.23
	2.00	.1805	.06	.22
	3.00	.1861	.06	.22
	4.00	.2857	.05	.30
	Total	.1715	.05	.30

TMctmTRAP2	1.00	.3845	.08	.26
	2.00	.3161	.11	.40
	3.00	.2370	.08	.25
	4.00	.1093	.06	.12
	Total	.2024	.06	.40
TMrttTRAP2	1.00	.2989	.16	.24
	2.00	.1936	.07	.26
	3.00	.2146	.06	.25
	4.00	.2772	.08	.27
	Total	.1845	.06	.27
TMcttTRAP2	1.00	.4403	.14	.31
	2.00	.3202	.07	.44
	3.00	.3606	.07	.40
	4.00	.2775	.05	.34
	Total	.2379	.05	.44
TMrollTRAP2	1.00	.4412	.11	.27
	2.00	.2596	.06	.28
	3.00	.2580	.08	.30
	4.00	.3624	.08	.37
	Total	.2272	.06	.37

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TMrtmTRAP2	Between Groups	.011	3	.004	.707	.562
	Within Groups	.087	16	.005		
	Total	.098	19			
TMctmTRAP2	Between Groups	.046	3	.015	2.255	.121
	Within Groups	.110	16	.007		
	Total	.156	19			
TMrttTRAP2	Between Groups	.018	3	.006	1.232	.331
	Within Groups	.079	16	.005		
	Total	.097	19			
TMcttTRAP2	Between Groups	.015	3	.005	.323	.809
	Within Groups	.254	16	.016		
	Total	.269	19			
TMrollTRAP2	Between Groups	.012	3	.004	.394	.759
	Within Groups	.156	16	.010		
	Total	.168	19			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) handquart	(J) handquart	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TMrtmTRAP2	1.00	2.00	.05130	.05076	.746	-.0939	.1965
		3.00	.07114	.05372	.562	-.0825	.2248
		4.00	.02568	.05372	.963	-.1280	.1794
	2.00	1.00	-.05130	.05076	.746	-.1965	.0939
		3.00	.01984	.04307	.967	-.1034	.1431
		4.00	-.02563	.04307	.932	-.1489	.0976
	3.00	1.00	-.07114	.05372	.562	-.2248	.0825
		2.00	-.01984	.04307	.967	-.1431	.1034
		4.00	-.04547	.04652	.764	-.1786	.0876
	4.00	1.00	-.02568	.05372	.963	-.1794	.1280
		2.00	.02563	.04307	.932	-.0976	.1489
		3.00	.04547	.04652	.764	-.0876	.1786
TMctmTRAP2	1.00	2.00	-.04552	.05709	.855	-.2089	.1178
		3.00	.00689	.06042	.999	-.1660	.1798
		4.00	.08033	.06042	.559	-.0925	.2532
	2.00	1.00	.04552	.05709	.855	-.1178	.2089
		3.00	.05241	.04845	.705	-.0862	.1910
		4.00	.12585	.04845	.082	-.0128	.2645

	3.00	1.00	-.00689	.06042	.999	-.1798	.1660
		2.00	-.05241	.04845	.705	-.1910	.0862
		4.00	.07344	.05233	.515	-.0763	.2231
	4.00	1.00	-.08033	.06042	.559	-.2532	.0925
		2.00	-.12585	.04845	.082	-.2645	.0128
		3.00	-.07344	.05233	.515	-.2231	.0763
TMrttTRAP2	1.00	2.00	.07154	.04852	.475	-.0673	.2104
		3.00	.08508	.05135	.377	-.0618	.2320
		4.00	.03146	.05135	.927	-.1155	.1784
	2.00	1.00	-.07154	.04852	.475	-.2104	.0673
		3.00	.01354	.04117	.987	-.1043	.1313
		4.00	-.04007	.04117	.766	-.1579	.0777
	3.00	1.00	-.08508	.05135	.377	-.2320	.0618
		2.00	-.01354	.04117	.987	-.1313	.1043
		4.00	-.05362	.04447	.632	-.1809	.0736
	4.00	1.00	-.03146	.05135	.927	-.1784	.1155
		2.00	.04007	.04117	.766	-.0777	.1579
		3.00	.05362	.04447	.632	-.0736	.1809
TMcttTRAP2	1.00	2.00	.01819	.08696	.997	-.2306	.2670
		3.00	.00353	.09203	1.000	-.2598	.2668
		4.00	.07163	.09203	.863	-.1917	.3349
	2.00	1.00	-.01819	.08696	.997	-.2670	.2306
		3.00	-.01466	.07379	.997	-.2258	.1964
		4.00	.05344	.07379	.886	-.1577	.2645

			Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
	3.00	1.00	-.00353	.09203	1.000	-.2668	.2598
		2.00	.01466	.07379	.997	-.1964	.2258
		4.00	.06810	.07970	.828	-.1599	.2961
	4.00	1.00	-.07163	.09203	.863	-.3349	.1917
		2.00	-.05344	.07379	.886	-.2645	.1577
		3.00	-.06810	.07970	.828	-.2961	.1599
TMrollTRAP2	1.00	2.00	.03057	.06816	.969	-.1644	.2256
		3.00	.06477	.07213	.806	-.1416	.2711
		4.00	.00623	.07213	1.000	-.2001	.2126
	2.00	1.00	-.03057	.06816	.969	-.2256	.1644
		3.00	.03420	.05783	.933	-.1313	.1997
		4.00	-.02433	.05783	.974	-.1898	.1411
	3.00	1.00	-.06477	.07213	.806	-.2711	.1416
		2.00	-.03420	.05783	.933	-.1997	.1313
		4.00	-.05854	.06247	.786	-.2373	.1202
	4.00	1.00	-.00623	.07213	1.000	-.2126	.2001
		2.00	.02433	.05783	.974	-.1411	.1898
		3.00	.05854	.06247	.786	-.1202	.2373

Homogeneous Subsets

TMrtmTRAP2

Tukey HSD[a,b]

		Subset for alpha = 0.05
handquart	N	1
3.00	5	.1089
2.00	7	.1288
4.00	5	.1544
1.00	3	.1801
Sig.		.482

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.565.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMctmTRAP2

Tukey HSD[a,b]

		Subset for alpha = 0.05
handquart	N	1
4.00	5	.0856

3.00	5	.1590
1.00	3	.1659
2.00	7	.2114
Sig.		.140

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.565.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

TMrttTRAP2

Tukey HSD[a,b]

		Subset for alpha = 0.05
handquart	N	1
3.00	5	.1201
2.00	7	.1336
4.00	5	.1737
1.00	3	.2051
Sig.		.297

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
4.565.

b. The group sizes are unequal. The
harmonic mean of the group sizes is used.
Type I error levels are not guaranteed.

TMcttTRAP2

Tukey HSD[a,b]

handquart	N	Subset for alpha = 0.05
		1
4.00	5	.1356
2.00	7	.1891
3.00	5	.2037
1.00	3	.2073
Sig.		.826

TMrollTRAP2

Tukey HSD[a,b]

handquart	N	Subset for alpha = 0.05
		1
3.00	5	.1469

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
4.565.

b. The group sizes are unequal. The
harmonic mean of the group sizes is used.
Type I error levels are not guaranteed.

Means for groups in homogeneous subsets
are displayed.

a. Uses Harmonic Mean Sample Size =
4.565.

b. The group sizes are unequal. The
harmonic mean of the group sizes is used.
Type I error levels are not guaranteed.

ECR Repeated Measures

Anthropometry and ECR Repeated Measures ANOVA

With each as separate trial

Within-Subjects Factors

Measure: MEASURE_1

trial	Dependent Variable
1	TMrtmECR
2	TMctmECR
3	TMrttECR
4	TMcttECR
5	TMrollECR2

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
trial	Sphericity Assumed	.034	4	.009	13.974	.000
	Greenhouse-Geisser	.034	2.273	.015	13.974	.000
	Huynh-Feldt	.034	2.598	.013	13.974	.000
	Lower-bound	.034	1.000	.034	13.974	.001
Error(trial)	Sphericity Assumed	.046	76	.001		
	Greenhouse-Geisser	.046	43.179	.001		
	Huynh-Feldt	.046	49.355	.001		

Lower-bound		.046	19.000		.002		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	8.058	1	8.058	672.748	.000
Error	.228	19	.012		

GLM WITH order

Within-Subjects Factors

Measure: MEASURE_1

trial	Dependent Variable
1	TMrtmECR
2	TMctmECR
3	TMrttECR
4	TMcttECR
5	TMrollECR2

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
trial	Sphericity Assumed	.005	4	.001	2.058	.095
	Greenhouse-Geisser	.005	2.208	.002	2.058	.137
	Huynh-Feldt	.005	2.669	.002	2.058	.125
	Lower-bound	.005	1.000	.005	2.058	.169
trial * order	Sphericity Assumed	.001	4	.000	.497	.738
	Greenhouse-Geisser	.001	2.208	.001	.497	.631
	Huynh-Feldt	.001	2.669	.000	.497	.665
	Lower-bound	.001	1.000	.001	.497	.490
Error(trial)	Sphericity Assumed	.045	72	.001		
	Greenhouse-Geisser	.045	39.736	.001		
	Huynh-Feldt	.045	48.044	.001		
	Lower-bound	.045	18.000	.003		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.339	1	1.339	107.532	.000

order	.003	1	.003	.280	.603
Error	.224	18	.012		

Repeated Measures DevicexLocationxgrouping

GLM TMrollECR2 BY group WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR
3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
group	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.005	2	.002	2.756	.078
	Greenhouse-Geisser	.005	1.244	.004	2.756	.105
	Huynh-Feldt	.005	1.453	.003	2.756	.097
	Lower-bound	.005	1.000	.005	2.756	.115
device * order	Sphericity Assumed	.001	2	.000	.371	.693
	Greenhouse-Geisser	.001	1.244	.001	.371	.595
	Huynh-Feldt	.001	1.453	.000	.371	.627
	Lower-bound	.001	1.000	.001	.371	.551
device * group	Sphericity Assumed	.000	2	.000	.143	.868
	Greenhouse-Geisser	.000	1.244	.000	.143	.764
	Huynh-Feldt	.000	1.453	.000	.143	.800
	Lower-bound	.000	1.000	.000	.143	.710
Error(device)	Sphericity Assumed	.029	34	.001		
	Greenhouse-Geisser	.029	21.153	.001		
	Huynh-Feldt	.029	24.693	.001		
	Lower-bound	.029	17.000	.002		
location	Sphericity Assumed	1.174E-7	1	1.174E-7	.000	.987
	Greenhouse-Geisser	1.174E-7	1.000	1.174E-7	.000	.987
	Huynh-Feldt	1.174E-7	1.000	1.174E-7	.000	.987

	Lower-bound	1.174E-7	1.000	1.174E-7	.000	.987
location * order	Sphericity Assumed	7.311E-6	1	7.311E-6	.017	.899
	Greenhouse-Geisser	7.311E-6	1.000	7.311E-6	.017	.899
	Huynh-Feldt	7.311E-6	1.000	7.311E-6	.017	.899
	Lower-bound	7.311E-6	1.000	7.311E-6	.017	.899
location * group	Sphericity Assumed	1.304E-5	1	1.304E-5	.030	.866
	Greenhouse-Geisser	1.304E-5	1.000	1.304E-5	.030	.866
	Huynh-Feldt	1.304E-5	1.000	1.304E-5	.030	.866
	Lower-bound	1.304E-5	1.000	1.304E-5	.030	.866
Error(location)	Sphericity Assumed	.008	17	.000		
	Greenhouse-Geisser	.008	17.000	.000		
	Huynh-Feldt	.008	17.000	.000		
	Lower-bound	.008	17.000	.000		
device * location	Sphericity Assumed	.000	2	.000	.867	.429
	Greenhouse-Geisser	.000	1.914	.000	.867	.425
	Huynh-Feldt	.000	2.000	.000	.867	.429
	Lower-bound	.000	1.000	.000	.867	.365
device * location * order	Sphericity Assumed	.001	2	.000	1.315	.282
	Greenhouse-Geisser	.001	1.914	.000	1.315	.281
	Huynh-Feldt	.001	2.000	.000	1.315	.282
	Lower-bound	.001	1.000	.001	1.315	.267
device * location * group	Sphericity Assumed	.000	2	.000	.577	.567
	Greenhouse-Geisser	.000	1.914	.000	.577	.560

	Huynh-Feldt	.000	2.000	.000	.577	.567
	Lower-bound	.000	1.000	.000	.577	.458
Error(device*location)	Sphericity Assumed	.008	34	.000		
	Greenhouse-Geisser	.008	32.534	.000		
	Huynh-Feldt	.008	34.000	.000		
	Lower-bound	.008	17.000	.000		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	device	location	Type III Sum of Squares	df	Mean Square	F
device	Linear		.001	1	.001	1.053
	Quadratic		.004	1	.004	3.774
device * order	Linear		.001	1	.001	.978
	Quadratic		8.470E-6	1	8.470E-6	.008
device * group	Linear		.000	1	.000	.331
	Quadratic		3.258E-5	1	3.258E-5	.030
Error(device)	Linear		.011	17	.001	
	Quadratic		.018	17	.001	
location		Linear	1.174E-7	1	1.174E-7	.000
location * order		Linear	7.311E-6	1	7.311E-6	.017
location * group		Linear	1.304E-5	1	1.304E-5	.030

			Type III Sum	df	Mean Square	F
Error(location)		Linear	.008	17	.000	
device * location	Linear	Linear	.000	1	.000	1.827
	Quadratic	Linear	6.095E-5	1	6.095E-5	.224
device * location * order	Linear	Linear	.001	1	.001	3.264
	Quadratic	Linear	2.743E-6	1	2.743E-6	.010
device * location * group	Linear	Linear	.000	1	.000	1.416
	Quadratic	Linear	4.227E-6	1	4.227E-6	.016
Error(device*location)	Linear	Linear	.003	17	.000	
	Quadratic	Linear	.005	17	.000	

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.608	1	1.608	101.449	.000
order	.004	1	.004	.266	.613
group	1.282E-7	1	1.282E-7	.000	.998
Error	.269	17	.016		

GLM BY heightquart WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR
3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
heightquart	1.00	5
	2.00	5
	3.00	4
	4.00	6

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.003	2	.002	2.359	.112
	Greenhouse-Geisser	.003	1.238	.003	2.359	.138
	Huynh-Feldt	.003	1.654	.002	2.359	.123
	Lower-bound	.003	1.000	.003	2.359	.145
device * order	Sphericity Assumed	.001	2	.000	.527	.596
	Greenhouse-Geisser	.001	1.238	.001	.527	.514
	Huynh-Feldt	.001	1.654	.000	.527	.563
	Lower-bound	.001	1.000	.001	.527	.479
device * heightquart	Sphericity Assumed	.008	6	.001	1.929	.108
	Greenhouse-Geisser	.008	3.714	.002	1.929	.151
	Huynh-Feldt	.008	4.961	.002	1.929	.126
	Lower-bound	.008	3.000	.003	1.929	.168
Error(device)	Sphericity Assumed	.021	30	.001		
	Greenhouse-Geisser	.021	18.570	.001		
	Huynh-Feldt	.021	24.807	.001		
	Lower-bound	.021	15.000	.001		
location	Sphericity Assumed	4.042E-6	1	4.042E-6	.012	.914
	Greenhouse-Geisser	4.042E-6	1.000	4.042E-6	.012	.914
	Huynh-Feldt	4.042E-6	1.000	4.042E-6	.012	.914
	Lower-bound	4.042E-6	1.000	4.042E-6	.012	.914
location * order	Sphericity Assumed	1.642E-5	1	1.642E-5	.049	.829
	Greenhouse-Geisser	1.642E-5	1.000	1.642E-5	.049	.829

	Huynh-Feldt	1.642E-5	1.000	1.642E-5	.049	.829
	Lower-bound	1.642E-5	1.000	1.642E-5	.049	.829
location * heightquart	Sphericity Assumed	.002	3	.001	2.402	.108
	Greenhouse-Geisser	.002	3.000	.001	2.402	.108
	Huynh-Feldt	.002	3.000	.001	2.402	.108
	Lower-bound	.002	3.000	.001	2.402	.108
Error(location)	Sphericity Assumed	.005	15	.000		
	Greenhouse-Geisser	.005	15.000	.000		
	Huynh-Feldt	.005	15.000	.000		
	Lower-bound	.005	15.000	.000		
device * location	Sphericity Assumed	.000	2	.000	.685	.512
	Greenhouse-Geisser	.000	1.891	.000	.685	.504
	Huynh-Feldt	.000	2.000	.000	.685	.512
	Lower-bound	.000	1.000	.000	.685	.421
device * location * order	Sphericity Assumed	.001	2	.000	1.015	.375
	Greenhouse-Geisser	.001	1.891	.000	1.015	.371
	Huynh-Feldt	.001	2.000	.000	1.015	.375
	Lower-bound	.001	1.000	.001	1.015	.330
device * location * heightquart	Sphericity Assumed	.001	6	8.967E-5	.361	.897
	Greenhouse-Geisser	.001	5.672	9.486E-5	.361	.889
	Huynh-Feldt	.001	6.000	8.967E-5	.361	.897
	Lower-bound	.001	3.000	.000	.361	.782
Error(device*location)	Sphericity Assumed	.007	30	.000		

		.007	28.360	.000		
Greenhouse-Geisser		.007	28.360	.000		
Huynh-Feldt		.007	30.000	.000		
Lower-bound		.007	15.000	.000		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.545	1	1.545	94.361	.000
order	.003	1	.003	.190	.669
heightquart	.024	3	.008	.488	.696
Error	.246	15	.016		

GLM BY shouldgroup WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR

3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
shouldgroup	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.005	2	.002	2.924	.067
	Greenhouse-Geisser	.005	1.230	.004	2.924	.096
	Huynh-Feldt	.005	1.434	.003	2.924	.087
	Lower-bound	.005	1.000	.005	2.924	.105
device * order	Sphericity Assumed	.000	2	.000	.274	.762
	Greenhouse-Geisser	.000	1.230	.000	.274	.654
	Huynh-Feldt	.000	1.434	.000	.274	.689
	Lower-bound	.000	1.000	.000	.274	.607
device * shouldgroup	Sphericity Assumed	.001	2	.000	.413	.665

	Greenhouse-Geisser	.001	1.230	.001	.413	.569
	Huynh-Feldt	.001	1.434	.000	.413	.599
	Lower-bound	.001	1.000	.001	.413	.529
Error(device)	Sphericity Assumed	.029	34	.001		
	Greenhouse-Geisser	.029	20.917	.001		
	Huynh-Feldt	.029	24.372	.001		
	Lower-bound	.029	17.000	.002		
location	Sphericity Assumed	3.536E-8	1	3.536E-8	.000	.993
	Greenhouse-Geisser	3.536E-8	1.000	3.536E-8	.000	.993
	Huynh-Feldt	3.536E-8	1.000	3.536E-8	.000	.993
	Lower-bound	3.536E-8	1.000	3.536E-8	.000	.993
location * order	Sphericity Assumed	8.090E-6	1	8.090E-6	.018	.894
	Greenhouse-Geisser	8.090E-6	1.000	8.090E-6	.018	.894
	Huynh-Feldt	8.090E-6	1.000	8.090E-6	.018	.894
	Lower-bound	8.090E-6	1.000	8.090E-6	.018	.894
location * shouldgroup	Sphericity Assumed	1.403E-6	1	1.403E-6	.003	.956
	Greenhouse-Geisser	1.403E-6	1.000	1.403E-6	.003	.956
	Huynh-Feldt	1.403E-6	1.000	1.403E-6	.003	.956
	Lower-bound	1.403E-6	1.000	1.403E-6	.003	.956
Error(location)	Sphericity Assumed	.008	17	.000		
	Greenhouse-Geisser	.008	17.000	.000		
	Huynh-Feldt	.008	17.000	.000		
	Lower-bound	.008	17.000	.000		

device * location	Sphericity Assumed	.000	2	.000	.871	.428
	Greenhouse-Geisser	.000	1.923	.000	.871	.424
	Huynh-Feldt	.000	2.000	.000	.871	.428
	Lower-bound	.000	1.000	.000	.871	.364
device * location * order	Sphericity Assumed	.001	2	.000	1.202	.313
	Greenhouse-Geisser	.001	1.923	.000	1.202	.312
	Huynh-Feldt	.001	2.000	.000	1.202	.313
	Lower-bound	.001	1.000	.001	1.202	.288
device * location * shouldgroup	Sphericity Assumed	.001	2	.000	1.145	.330
	Greenhouse-Geisser	.001	1.923	.000	1.145	.329
	Huynh-Feldt	.001	2.000	.000	1.145	.330
	Lower-bound	.001	1.000	.001	1.145	.300
Error(device*location)	Sphericity Assumed	.007	34	.000		
	Greenhouse-Geisser	.007	32.697	.000		
	Huynh-Feldt	.007	34.000	.000		
	Lower-bound	.007	17.000	.000		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.570	1	1.570	99.542	.000
order	.005	1	.005	.307	.587

shouldgroup	.001	1	.001	.090	.768
Error	.268	17	.016		

GLM 2 BY shouldquart WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR
3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
shouldquart	1.00	4
	2.00	6
	3.00	4
	4.00	6

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.006	2	.003	3.794	.034
	Greenhouse-Geisser	.006	1.244	.004	3.794	.059
	Huynh-Feldt	.006	1.664	.003	3.794	.043
	Lower-bound	.006	1.000	.006	3.794	.070
device * order	Sphericity Assumed	.000	2	.000	.249	.781
	Greenhouse-Geisser	.000	1.244	.000	.249	.675
	Huynh-Feldt	.000	1.664	.000	.249	.741
	Lower-bound	.000	1.000	.000	.249	.625
device * shouldquart	Sphericity Assumed	.008	6	.001	1.765	.140
	Greenhouse-Geisser	.008	3.733	.002	1.765	.181
	Huynh-Feldt	.008	4.992	.002	1.765	.157
	Lower-bound	.008	3.000	.003	1.765	.197
Error(device)	Sphericity Assumed	.022	30	.001		
	Greenhouse-Geisser	.022	18.666	.001		
	Huynh-Feldt	.022	24.958	.001		
	Lower-bound	.022	15.000	.001		
location	Sphericity Assumed	1.077E-6	1	1.077E-6	.002	.961
	Greenhouse-Geisser	1.077E-6	1.000	1.077E-6	.002	.961
	Huynh-Feldt	1.077E-6	1.000	1.077E-6	.002	.961

			df		F	Sig.
	Lower-bound	1.077E-6	1.000	1.077E-6	.002	.961
location * order	Sphericity Assumed	4.761E-5	1	4.761E-5	.107	.748
	Greenhouse-Geisser	4.761E-5	1.000	4.761E-5	.107	.748
	Huynh-Feldt	4.761E-5	1.000	4.761E-5	.107	.748
	Lower-bound	4.761E-5	1.000	4.761E-5	.107	.748
location * shouldquart	Sphericity Assumed	.001	3	.000	.639	.601
	Greenhouse-Geisser	.001	3.000	.000	.639	.601
	Huynh-Feldt	.001	3.000	.000	.639	.601
	Lower-bound	.001	3.000	.000	.639	.601
Error(location)	Sphericity Assumed	.007	15	.000		
	Greenhouse-Geisser	.007	15.000	.000		
	Huynh-Feldt	.007	15.000	.000		
	Lower-bound	.007	15.000	.000		
device * location	Sphericity Assumed	.000	2	.000	.904	.416
	Greenhouse-Geisser	.000	1.849	.000	.904	.409
	Huynh-Feldt	.000	2.000	.000	.904	.416
	Lower-bound	.000	1.000	.000	.904	.357
device * location * order	Sphericity Assumed	.000	2	.000	.875	.427
	Greenhouse-Geisser	.000	1.849	.000	.875	.420
	Huynh-Feldt	.000	2.000	.000	.875	.427
	Lower-bound	.000	1.000	.000	.875	.364
device * location * shouldquart	Sphericity Assumed	.002	6	.000	2.143	.077
	Greenhouse-Geisser	.002	5.547	.000	2.143	.084

		.002	6.000	.000	2.143	.077
Huynh-Feldt						
Lower-bound		.002	3.000	.001	2.143	.138
Error(device*location)	Sphericity Assumed	.006	30	.000		
	Greenhouse-Geisser	.006	27.734	.000		
	Huynh-Feldt	.006	30.000	.000		
	Lower-bound	.006	15.000	.000		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.579	1	1.579	99.563	.000
order	.004	1	.004	.239	.632
shouldquart	.032	3	.011	.666	.586
Error	.238	15	.016		

GLM BY armgroup WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable

1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR
3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
armgroup	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.005	2	.002	2.756	.078
	Greenhouse-Geisser	.005	1.244	.004	2.756	.105
	Huynh-Feldt	.005	1.453	.003	2.756	.097
	Lower-bound	.005	1.000	.005	2.756	.115
device * order	Sphericity Assumed	.001	2	.000	.371	.693

		Type III Sum of Squares	df	Mean Square	F	Sig.
	Greenhouse-Geisser	.001	1.244	.001	.371	.595
	Huynh-Feldt	.001	1.453	.000	.371	.627
	Lower-bound	.001	1.000	.001	.371	.551
device * armgroup	Sphericity Assumed	.000	2	.000	.143	.868
	Greenhouse-Geisser	.000	1.244	.000	.143	.764
	Huynh-Feldt	.000	1.453	.000	.143	.800
	Lower-bound	.000	1.000	.000	.143	.710
Error(device)	Sphericity Assumed	.029	34	.001		
	Greenhouse-Geisser	.029	21.153	.001		
	Huynh-Feldt	.029	24.693	.001		
	Lower-bound	.029	17.000	.002		
location	Sphericity Assumed	1.174E-7	1	1.174E-7	.000	.987
	Greenhouse-Geisser	1.174E-7	1.000	1.174E-7	.000	.987
	Huynh-Feldt	1.174E-7	1.000	1.174E-7	.000	.987
	Lower-bound	1.174E-7	1.000	1.174E-7	.000	.987
location * order	Sphericity Assumed	7.311E-6	1	7.311E-6	.017	.899
	Greenhouse-Geisser	7.311E-6	1.000	7.311E-6	.017	.899
	Huynh-Feldt	7.311E-6	1.000	7.311E-6	.017	.899
	Lower-bound	7.311E-6	1.000	7.311E-6	.017	.899
location * armgroup	Sphericity Assumed	1.304E-5	1	1.304E-5	.030	.866
	Greenhouse-Geisser	1.304E-5	1.000	1.304E-5	.030	.866
	Huynh-Feldt	1.304E-5	1.000	1.304E-5	.030	.866
	Lower-bound	1.304E-5	1.000	1.304E-5	.030	.866

Error(location)	Sphericity Assumed	.008	17	.000		
	Greenhouse-Geisser	.008	17.000	.000		
	Huynh-Feldt	.008	17.000	.000		
	Lower-bound	.008	17.000	.000		
device * location	Sphericity Assumed	.000	2	.000	.867	.429
	Greenhouse-Geisser	.000	1.914	.000	.867	.425
	Huynh-Feldt	.000	2.000	.000	.867	.429
	Lower-bound	.000	1.000	.000	.867	.365
device * location * order	Sphericity Assumed	.001	2	.000	1.315	.282
	Greenhouse-Geisser	.001	1.914	.000	1.315	.281
	Huynh-Feldt	.001	2.000	.000	1.315	.282
	Lower-bound	.001	1.000	.001	1.315	.267
device * location * armgroup	Sphericity Assumed	.000	2	.000	.577	.567
	Greenhouse-Geisser	.000	1.914	.000	.577	.560
	Huynh-Feldt	.000	2.000	.000	.577	.567
	Lower-bound	.000	1.000	.000	.577	.458
Error(device*location)	Sphericity Assumed	.008	34	.000		
	Greenhouse-Geisser	.008	32.534	.000		
	Huynh-Feldt	.008	34.000	.000		
	Lower-bound	.008	17.000	.000		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.608	1	1.608	101.449	.000
order	.004	1	.004	.266	.613
armgroup	1.282E-7	1	1.282E-7	.000	.998
Error	.269	17	.016		

GLM BY armquart WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR
3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
armquart	1.00	5
	2.00	5
	3.00	5
	4.00	5

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.004	2	.002	2.135	.136
	Greenhouse-Geisser	.004	1.233	.003	2.135	.159
	Huynh-Feldt	.004	1.646	.002	2.135	.146
	Lower-bound	.004	1.000	.004	2.135	.165
device * order	Sphericity Assumed	.001	2	.000	.401	.673
	Greenhouse-Geisser	.001	1.233	.001	.401	.577
	Huynh-Feldt	.001	1.646	.000	.401	.634
	Lower-bound	.001	1.000	.001	.401	.536
device * armquart	Sphericity Assumed	.002	6	.000	.269	.947
	Greenhouse-Geisser	.002	3.700	.000	.269	.882
	Huynh-Feldt	.002	4.939	.000	.269	.924
	Lower-bound	.002	3.000	.001	.269	.847

Error(device)	Sphericity Assumed	.028	30	.001		
	Greenhouse-Geisser	.028	18.500	.002		
	Huynh-Feldt	.028	24.697	.001		
	Lower-bound	.028	15.000	.002		
location	Sphericity Assumed	8.770E-7	1	8.770E-7	.002	.963
	Greenhouse-Geisser	8.770E-7	1.000	8.770E-7	.002	.963
	Huynh-Feldt	8.770E-7	1.000	8.770E-7	.002	.963
	Lower-bound	8.770E-7	1.000	8.770E-7	.002	.963
location * order	Sphericity Assumed	1.642E-5	1	1.642E-5	.042	.839
	Greenhouse-Geisser	1.642E-5	1.000	1.642E-5	.042	.839
	Huynh-Feldt	1.642E-5	1.000	1.642E-5	.042	.839
	Lower-bound	1.642E-5	1.000	1.642E-5	.042	.839
location * armquart	Sphericity Assumed	.002	3	.001	1.483	.259
	Greenhouse-Geisser	.002	3.000	.001	1.483	.259
	Huynh-Feldt	.002	3.000	.001	1.483	.259
	Lower-bound	.002	3.000	.001	1.483	.259
Error(location)	Sphericity Assumed	.006	15	.000		
	Greenhouse-Geisser	.006	15.000	.000		
	Huynh-Feldt	.006	15.000	.000		
	Lower-bound	.006	15.000	.000		
device * location	Sphericity Assumed	.000	2	.000	.676	.516
	Greenhouse-Geisser	.000	1.864	.000	.676	.507
	Huynh-Feldt	.000	2.000	.000	.676	.516

	Lower-bound	.000	1.000	.000	.676	.424
device * location * order	Sphericity Assumed	.001	2	.000	1.051	.362
	Greenhouse-Geisser	.001	1.864	.000	1.051	.359
	Huynh-Feldt	.001	2.000	.000	1.051	.362
	Lower-bound	.001	1.000	.001	1.051	.322
device * location * armquart	Sphericity Assumed	.001	6	.000	.553	.764
	Greenhouse-Geisser	.001	5.592	.000	.553	.752
	Huynh-Feldt	.001	6.000	.000	.553	.764
	Lower-bound	.001	3.000	.000	.553	.654
Error(device*location)	Sphericity Assumed	.007	30	.000		
	Greenhouse-Geisser	.007	27.959	.000		
	Huynh-Feldt	.007	30.000	.000		
	Lower-bound	.007	15.000	.000		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.573	1	1.573	90.161	.000
order	.003	1	.003	.178	.679
armquart	.008	3	.003	.149	.929
Error	.262	15	.017		

GLM BY handgroup WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR
3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
handgroup	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.005	2	.002	2.881	.070

	Greenhouse-Geisser	.005	1.250	.004	2.881	.097
	Huynh-Feldt	.005	1.460	.003	2.881	.089
	Lower-bound	.005	1.000	.005	2.881	.108
device * order	Sphericity Assumed	.001	2	.000	.322	.727
	Greenhouse-Geisser	.001	1.250	.000	.322	.626
	Huynh-Feldt	.001	1.460	.000	.322	.659
	Lower-bound	.001	1.000	.001	.322	.578
device * handgroup	Sphericity Assumed	.000	2	.000	.174	.841
	Greenhouse-Geisser	.000	1.250	.000	.174	.736
	Huynh-Feldt	.000	1.460	.000	.174	.772
	Lower-bound	.000	1.000	.000	.174	.682
Error(device)	Sphericity Assumed	.029	34	.001		
	Greenhouse-Geisser	.029	21.251	.001		
	Huynh-Feldt	.029	24.826	.001		
	Lower-bound	.029	17.000	.002		
location	Sphericity Assumed	6.827E-6	1	6.827E-6	.016	.900
	Greenhouse-Geisser	6.827E-6	1.000	6.827E-6	.016	.900
	Huynh-Feldt	6.827E-6	1.000	6.827E-6	.016	.900
	Lower-bound	6.827E-6	1.000	6.827E-6	.016	.900
location * order	Sphericity Assumed	2.839E-8	1	2.839E-8	.000	.994
	Greenhouse-Geisser	2.839E-8	1.000	2.839E-8	.000	.994
	Huynh-Feldt	2.839E-8	1.000	2.839E-8	.000	.994
	Lower-bound	2.839E-8	1.000	2.839E-8	.000	.994

location * handgroup	Sphericity Assumed	.000	1	.000	.743	.401
	Greenhouse-Geisser	.000	1.000	.000	.743	.401
	Huynh-Feldt	.000	1.000	.000	.743	.401
	Lower-bound	.000	1.000	.000	.743	.401
Error(location)	Sphericity Assumed	.007	17	.000		
	Greenhouse-Geisser	.007	17.000	.000		
	Huynh-Feldt	.007	17.000	.000		
	Lower-bound	.007	17.000	.000		
device * location	Sphericity Assumed	.000	2	.000	.958	.394
	Greenhouse-Geisser	.000	1.926	.000	.958	.391
	Huynh-Feldt	.000	2.000	.000	.958	.394
	Lower-bound	.000	1.000	.000	.958	.341
device * location * order	Sphericity Assumed	.001	2	.000	1.440	.251
	Greenhouse-Geisser	.001	1.926	.000	1.440	.252
	Huynh-Feldt	.001	2.000	.000	1.440	.251
	Lower-bound	.001	1.000	.001	1.440	.247
device * location * handgroup	Sphericity Assumed	.000	2	6.369E-5	.276	.761
	Greenhouse-Geisser	.000	1.926	6.615E-5	.276	.753
	Huynh-Feldt	.000	2.000	6.369E-5	.276	.761
	Lower-bound	.000	1.000	.000	.276	.606
Error(device*location)	Sphericity Assumed	.008	34	.000		
	Greenhouse-Geisser	.008	32.736	.000		
	Huynh-Feldt	.008	34.000	.000		

Lower-bound		.008	17.000	.000		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.567	1	1.567	99.652	.000
order	.005	1	.005	.320	.579
handgroup	.002	1	.002	.143	.710
Error	.267	17	.016		

GLM BY handquart WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmECR
	2	TMctmECR
2	1	TMrttECR
	2	TMcttECR
3	1	TMdummyECR
	2	TMrollECR2

Between-Subjects Factors

		N
handquart	1.00	3
	2.00	7
	3.00	5
	4.00	5

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.005	2	.002	2.494	.100
	Greenhouse-Geisser	.005	1.160	.004	2.494	.129
	Huynh-Feldt	.005	1.532	.003	2.494	.116
	Lower-bound	.005	1.000	.005	2.494	.135
device * order	Sphericity Assumed	.001	2	.000	.415	.664
	Greenhouse-Geisser	.001	1.160	.001	.415	.558
	Huynh-Feldt	.001	1.532	.001	.415	.612
	Lower-bound	.001	1.000	.001	.415	.529
device * handquart	Sphericity Assumed	.002	6	.000	.350	.904
	Greenhouse-Geisser	.002	3.480	.001	.350	.817
	Huynh-Feldt	.002	4.595	.000	.350	.864

	Lower-bound	.002	3.000	.001	.350	.790
Error(device)	Sphericity Assumed	.028	30	.001		
	Greenhouse-Geisser	.028	17.399	.002		
	Huynh-Feldt	.028	22.975	.001		
	Lower-bound	.028	15.000	.002		
location	Sphericity Assumed	3.524E-7	1	3.524E-7	.001	.979
	Greenhouse-Geisser	3.524E-7	1.000	3.524E-7	.001	.979
	Huynh-Feldt	3.524E-7	1.000	3.524E-7	.001	.979
	Lower-bound	3.524E-7	1.000	3.524E-7	.001	.979
location * order	Sphericity Assumed	5.311E-7	1	5.311E-7	.001	.974
	Greenhouse-Geisser	5.311E-7	1.000	5.311E-7	.001	.974
	Huynh-Feldt	5.311E-7	1.000	5.311E-7	.001	.974
	Lower-bound	5.311E-7	1.000	5.311E-7	.001	.974
location * handquart	Sphericity Assumed	.000	3	.000	.315	.814
	Greenhouse-Geisser	.000	3.000	.000	.315	.814
	Huynh-Feldt	.000	3.000	.000	.315	.814
	Lower-bound	.000	3.000	.000	.315	.814
Error(location)	Sphericity Assumed	.007	15	.000		
	Greenhouse-Geisser	.007	15.000	.000		
	Huynh-Feldt	.007	15.000	.000		
	Lower-bound	.007	15.000	.000		
device * location	Sphericity Assumed	.001	2	.000	1.600	.219
	Greenhouse-Geisser	.001	1.813	.000	1.600	.221

	Huynh-Feldt	.001	2.000	.000	1.600	.219
	Lower-bound	.001	1.000	.001	1.600	.225
device * location * order	Sphericity Assumed	.001	2	.000	2.674	.085
	Greenhouse-Geisser	.001	1.813	.000	2.674	.092
	Huynh-Feldt	.001	2.000	.000	2.674	.085
	Lower-bound	.001	1.000	.001	2.674	.123
device * location * handquart	Sphericity Assumed	.003	6	.001	3.163	.016
	Greenhouse-Geisser	.003	5.440	.001	3.163	.020
	Huynh-Feldt	.003	6.000	.001	3.163	.016
	Lower-bound	.003	3.000	.001	3.163	.056
Error(device*location)	Sphericity Assumed	.005	30	.000		
	Greenhouse-Geisser	.005	27.199	.000		
	Huynh-Feldt	.005	30.000	.000		
	Lower-bound	.005	15.000	.000		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1.443	1	1.443	96.841	.000
order	.005	1	.005	.355	.560
handquart	.046	3	.015	1.028	.408

Error		.224	15	.015	

TRAP Repeated Measures

Anthropometry and TRAP Repeated Measures

GLM BY height group

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2
	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
group	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.007	2	.003	1.294	.287
	Greenhouse-Geisser	.007	1.970	.003	1.294	.287
	Huynh-Feldt	.007	2.000	.003	1.294	.287
	Lower-bound	.007	1.000	.007	1.294	.271
device * order	Sphericity Assumed	.001	2	.000	.177	.838
	Greenhouse-Geisser	.001	1.970	.000	.177	.835
	Huynh-Feldt	.001	2.000	.000	.177	.838
	Lower-bound	.001	1.000	.001	.177	.679
device * group	Sphericity Assumed	.002	2	.001	.349	.708
	Greenhouse-Geisser	.002	1.970	.001	.349	.705
	Huynh-Feldt	.002	2.000	.001	.349	.708
	Lower-bound	.002	1.000	.002	.349	.563
Error(device)	Sphericity Assumed	.089	34	.003		
	Greenhouse-Geisser	.089	33.494	.003		
	Huynh-Feldt	.089	34.000	.003		
	Lower-bound	.089	17.000	.005		
location	Sphericity Assumed	.004	1	.004	.435	.518

	Greenhouse-Geisser	.004	1.000	.004	.435	.518
	Huynh-Feldt	.004	1.000	.004	.435	.518
	Lower-bound	.004	1.000	.004	.435	.518
location * order	Sphericity Assumed	.000	1	.000	.019	.891
	Greenhouse-Geisser	.000	1.000	.000	.019	.891
	Huynh-Feldt	.000	1.000	.000	.019	.891
	Lower-bound	.000	1.000	.000	.019	.891
location * group	Sphericity Assumed	.017	1	.017	2.069	.169
	Greenhouse-Geisser	.017	1.000	.017	2.069	.169
	Huynh-Feldt	.017	1.000	.017	2.069	.169
	Lower-bound	.017	1.000	.017	2.069	.169
Error(location)	Sphericity Assumed	.140	17	.008		
	Greenhouse-Geisser	.140	17.000	.008		
	Huynh-Feldt	.140	17.000	.008		
	Lower-bound	.140	17.000	.008		
device * location	Sphericity Assumed	.005	2	.003	.525	.596
	Greenhouse-Geisser	.005	1.861	.003	.525	.584
	Huynh-Feldt	.005	2.000	.003	.525	.596
	Lower-bound	.005	1.000	.005	.525	.478
device * location * order	Sphericity Assumed	.007	2	.004	.763	.474
	Greenhouse-Geisser	.007	1.861	.004	.763	.466
	Huynh-Feldt	.007	2.000	.004	.763	.474
	Lower-bound	.007	1.000	.007	.763	.394

		.022	2	.011	2.283	.117
device * location * group	Sphericity Assumed	.022	2	.011	2.283	.117
	Greenhouse-Geisser	.022	1.861	.012	2.283	.122
	Huynh-Feldt	.022	2.000	.011	2.283	.117
	Lower-bound	.022	1.000	.022	2.283	.149
Error(device*location)	Sphericity Assumed	.162	34	.005		
	Greenhouse-Geisser	.162	31.638	.005		
	Huynh-Feldt	.162	34.000	.005		
	Lower-bound	.162	17.000	.010		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.454	1	.454	19.817	.000
order	.011	1	.011	.487	.495
group	.028	1	.028	1.203	.288
Error	.390	17	.023		

GLM BY heightquart WITH

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2
	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
heightquart	1.00	5
	2.00	5
	3.00	4
	4.00	6

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.004	2	.002	.948	.399
	Greenhouse-Geisser	.004	1.971	.002	.948	.398

	Huynh-Feldt	.004	2.000	.002	.948	.399
	Lower-bound	.004	1.000	.004	.948	.346
device * order	Sphericity Assumed	.001	2	.000	.167	.847
	Greenhouse-Geisser	.001	1.971	.000	.167	.844
	Huynh-Feldt	.001	2.000	.000	.167	.847
	Lower-bound	.001	1.000	.001	.167	.689
device * heightquart	Sphericity Assumed	.024	6	.004	1.819	.129
	Greenhouse-Geisser	.024	5.913	.004	1.819	.130
	Huynh-Feldt	.024	6.000	.004	1.819	.129
	Lower-bound	.024	3.000	.008	1.819	.187
Error(device)	Sphericity Assumed	.067	30	.002		
	Greenhouse-Geisser	.067	29.567	.002		
	Huynh-Feldt	.067	30.000	.002		
	Lower-bound	.067	15.000	.004		
location	Sphericity Assumed	.003	1	.003	.311	.585
	Greenhouse-Geisser	.003	1.000	.003	.311	.585
	Huynh-Feldt	.003	1.000	.003	.311	.585
	Lower-bound	.003	1.000	.003	.311	.585
location * order	Sphericity Assumed	1.932E-7	1	1.932E-7	.000	.996
	Greenhouse-Geisser	1.932E-7	1.000	1.932E-7	.000	.996
	Huynh-Feldt	1.932E-7	1.000	1.932E-7	.000	.996
	Lower-bound	1.932E-7	1.000	1.932E-7	.000	.996
location * heightquart	Sphericity Assumed	.026	3	.009	.974	.431

	Greenhouse-Geisser	.026	3.000	.009	.974	.431
	Huynh-Feldt	.026	3.000	.009	.974	.431
	Lower-bound	.026	3.000	.009	.974	.431
Error(location)	Sphericity Assumed	.132	15	.009		
	Greenhouse-Geisser	.132	15.000	.009		
	Huynh-Feldt	.132	15.000	.009		
	Lower-bound	.132	15.000	.009		
device * location	Sphericity Assumed	.006	2	.003	.608	.551
	Greenhouse-Geisser	.006	1.808	.003	.608	.536
	Huynh-Feldt	.006	2.000	.003	.608	.551
	Lower-bound	.006	1.000	.006	.608	.448
device * location * order	Sphericity Assumed	.007	2	.003	.686	.511
	Greenhouse-Geisser	.007	1.808	.004	.686	.498
	Huynh-Feldt	.007	2.000	.003	.686	.511
	Lower-bound	.007	1.000	.007	.686	.421
device * location * heightquart	Sphericity Assumed	.040	6	.007	1.391	.251
	Greenhouse-Geisser	.040	5.423	.007	1.391	.257
	Huynh-Feldt	.040	6.000	.007	1.391	.251
	Lower-bound	.040	3.000	.013	1.391	.284
Error(device*location)	Sphericity Assumed	.144	30	.005		
	Greenhouse-Geisser	.144	27.117	.005		
	Huynh-Feldt	.144	30.000	.005		
	Lower-bound	.144	15.000	.010		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.372	1	.372	25.988	.000
order	.018	1	.018	1.265	.278
heightquart	.202	3	.067	4.714	.016
Error	.215	15	.014		

GLM BY shouldgroup WITH

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2
	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
shouldgroup	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.008	2	.004	1.656	.206
	Greenhouse-Geisser	.008	1.961	.004	1.656	.207
	Huynh-Feldt	.008	2.000	.004	1.656	.206
	Lower-bound	.008	1.000	.008	1.656	.215
device * order	Sphericity Assumed	.002	2	.001	.303	.740
	Greenhouse-Geisser	.002	1.961	.001	.303	.736
	Huynh-Feldt	.002	2.000	.001	.303	.740
	Lower-bound	.002	1.000	.002	.303	.589
device * shouldgroup	Sphericity Assumed	.006	2	.003	1.238	.303
	Greenhouse-Geisser	.006	1.961	.003	1.238	.302
	Huynh-Feldt	.006	2.000	.003	1.238	.303
	Lower-bound	.006	1.000	.006	1.238	.281
Error(device)	Sphericity Assumed	.085	34	.003		

	Greenhouse-Geisser	.085	33.334	.003		
	Huynh-Feldt	.085	34.000	.003		
	Lower-bound	.085	17.000	.005		
location	Sphericity Assumed	.005	1	.005	.544	.471
	Greenhouse-Geisser	.005	1.000	.005	.544	.471
	Huynh-Feldt	.005	1.000	.005	.544	.471
	Lower-bound	.005	1.000	.005	.544	.471
location * order	Sphericity Assumed	.001	1	.001	.063	.805
	Greenhouse-Geisser	.001	1.000	.001	.063	.805
	Huynh-Feldt	.001	1.000	.001	.063	.805
	Lower-bound	.001	1.000	.001	.063	.805
location * shouldgroup	Sphericity Assumed	.006	1	.006	.701	.414
	Greenhouse-Geisser	.006	1.000	.006	.701	.414
	Huynh-Feldt	.006	1.000	.006	.701	.414
	Lower-bound	.006	1.000	.006	.701	.414
Error(location)	Sphericity Assumed	.151	17	.009		
	Greenhouse-Geisser	.151	17.000	.009		
	Huynh-Feldt	.151	17.000	.009		
	Lower-bound	.151	17.000	.009		
device * location	Sphericity Assumed	.005	2	.003	.480	.623
	Greenhouse-Geisser	.005	1.775	.003	.480	.601
	Huynh-Feldt	.005	2.000	.003	.480	.623
	Lower-bound	.005	1.000	.005	.480	.498

device * location * order	Sphericity Assumed	.008	2	.004	.710	.499
	Greenhouse-Geisser	.008	1.775	.004	.710	.484
	Huynh-Feldt	.008	2.000	.004	.710	.499
	Lower-bound	.008	1.000	.008	.710	.411
device * location * shouldgroup	Sphericity Assumed	.001	2	.001	.104	.901
	Greenhouse-Geisser	.001	1.775	.001	.104	.880
	Huynh-Feldt	.001	2.000	.001	.104	.901
	Lower-bound	.001	1.000	.001	.104	.751
Error(device*location)	Sphericity Assumed	.183	34	.005		
	Greenhouse-Geisser	.183	30.170	.006		
	Huynh-Feldt	.183	34.000	.005		
	Lower-bound	.183	17.000	.011		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	device location		Type III Sum of Squares	df	Mean Square	F
device	Linear		.008	1	.008	3.272
	Quadratic		.000	1	.000	.146
device * order	Linear		.001	1	.001	.534
	Quadratic		.000	1	.000	.087
device * shouldgroup	Linear		.006	1	.006	2.481

	Quadratic		.000	1	.000	.076
Error(device)	Linear		.041	17	.002	
	Quadratic		.044	17	.003	
location		Linear	.005	1	.005	.544
location * order		Linear	.001	1	.001	.063
location * shouldgroup		Linear	.006	1	.006	.701
Error(location)		Linear	.151	17	.009	
device * location	Linear	Linear	.002	1	.002	.395
	Quadratic	Linear	.003	1	.003	.574
device * location * order	Linear	Linear	.001	1	.001	.261
	Quadratic	Linear	.006	1	.006	1.211
device * location * shouldgroup	Linear	Linear	.000	1	.000	.034
	Quadratic	Linear	.001	1	.001	.182
Error(device*location)	Linear	Linear	.096	17	.006	
	Quadratic	Linear	.086	17	.005	

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.430	1	.430	17.938	.001
order	.014	1	.014	.585	.455
shouldgroup	.010	1	.010	.398	.537

Error	.408	17	.024		

GLM BY shouldquart WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2
	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
shouldquart	1.00	4
	2.00	6
	3.00	4
	4.00	6

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.008	2	.004	1.800	.183
	Greenhouse-Geisser	.008	1.960	.004	1.800	.184
	Huynh-Feldt	.008	2.000	.004	1.800	.183
	Lower-bound	.008	1.000	.008	1.800	.200
device * order	Sphericity Assumed	.001	2	.001	.310	.736
	Greenhouse-Geisser	.001	1.960	.001	.310	.731
	Huynh-Feldt	.001	2.000	.001	.310	.736
	Lower-bound	.001	1.000	.001	.310	.586
device * shouldquart	Sphericity Assumed	.026	6	.004	2.037	.092
	Greenhouse-Geisser	.026	5.880	.004	2.037	.093
	Huynh-Feldt	.026	6.000	.004	2.037	.092
	Lower-bound	.026	3.000	.009	2.037	.152
Error(device)	Sphericity Assumed	.065	30	.002		
	Greenhouse-Geisser	.065	29.398	.002		
	Huynh-Feldt	.065	30.000	.002		
	Lower-bound	.065	15.000	.004		
location	Sphericity Assumed	.003	1	.003	.514	.484
	Greenhouse-Geisser	.003	1.000	.003	.514	.484
	Huynh-Feldt	.003	1.000	.003	.514	.484
	Lower-bound	.003	1.000	.003	.514	.484

location * order	Sphericity Assumed	4.434E-6	1	4.434E-6	.001	.980
	Greenhouse-Geisser	4.434E-6	1.000	4.434E-6	.001	.980
	Huynh-Feldt	4.434E-6	1.000	4.434E-6	.001	.980
	Lower-bound	4.434E-6	1.000	4.434E-6	.001	.980
location * shouldquart	Sphericity Assumed	.059	3	.020	2.963	.066
	Greenhouse-Geisser	.059	3.000	.020	2.963	.066
	Huynh-Feldt	.059	3.000	.020	2.963	.066
	Lower-bound	.059	3.000	.020	2.963	.066
Error(location)	Sphericity Assumed	.099	15	.007		
	Greenhouse-Geisser	.099	15.000	.007		
	Huynh-Feldt	.099	15.000	.007		
	Lower-bound	.099	15.000	.007		
device * location	Sphericity Assumed	.005	2	.003	.489	.618
	Greenhouse-Geisser	.005	1.866	.003	.489	.606
	Huynh-Feldt	.005	2.000	.003	.489	.618
	Lower-bound	.005	1.000	.005	.489	.495
device * location * order	Sphericity Assumed	.008	2	.004	.780	.468
	Greenhouse-Geisser	.008	1.866	.004	.780	.460
	Huynh-Feldt	.008	2.000	.004	.780	.468
	Lower-bound	.008	1.000	.008	.780	.391
device * location * shouldquart	Sphericity Assumed	.025	6	.004	.791	.584
	Greenhouse-Geisser	.025	5.599	.004	.791	.577
	Huynh-Feldt	.025	6.000	.004	.791	.584

		.025	3.000	.008	.791	.518
	Lower-bound	.025	3.000	.008	.791	.518
Error(device*location)	Sphericity Assumed	.159	30	.005		
	Greenhouse-Geisser	.159	27.994	.006		
	Huynh-Feldt	.159	30.000	.005		
	Lower-bound	.159	15.000	.011		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.416	1	.416	23.210	.000
order	.016	1	.016	.904	.357
shouldquart	.148	3	.049	2.752	.079
Error	.269	15	.018		

GLM BY armgroup WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2

	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
armgroup	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.007	2	.003	1.294	.287
	Greenhouse-Geisser	.007	1.970	.003	1.294	.287
	Huynh-Feldt	.007	2.000	.003	1.294	.287
	Lower-bound	.007	1.000	.007	1.294	.271
device * order	Sphericity Assumed	.001	2	.000	.177	.838
	Greenhouse-Geisser	.001	1.970	.000	.177	.835
	Huynh-Feldt	.001	2.000	.000	.177	.838
	Lower-bound	.001	1.000	.001	.177	.679

device * armgroup	Sphericity Assumed	.002	2	.001	.349	.708
	Greenhouse-Geisser	.002	1.970	.001	.349	.705
	Huynh-Feldt	.002	2.000	.001	.349	.708
	Lower-bound	.002	1.000	.002	.349	.563
Error(device)	Sphericity Assumed	.089	34	.003		
	Greenhouse-Geisser	.089	33.494	.003		
	Huynh-Feldt	.089	34.000	.003		
	Lower-bound	.089	17.000	.005		
location	Sphericity Assumed	.004	1	.004	.435	.518
	Greenhouse-Geisser	.004	1.000	.004	.435	.518
	Huynh-Feldt	.004	1.000	.004	.435	.518
	Lower-bound	.004	1.000	.004	.435	.518
location * order	Sphericity Assumed	.000	1	.000	.019	.891
	Greenhouse-Geisser	.000	1.000	.000	.019	.891
	Huynh-Feldt	.000	1.000	.000	.019	.891
	Lower-bound	.000	1.000	.000	.019	.891
location * armgroup	Sphericity Assumed	.017	1	.017	2.069	.169
	Greenhouse-Geisser	.017	1.000	.017	2.069	.169
	Huynh-Feldt	.017	1.000	.017	2.069	.169
	Lower-bound	.017	1.000	.017	2.069	.169
Error(location)	Sphericity Assumed	.140	17	.008		
	Greenhouse-Geisser	.140	17.000	.008		
	Huynh-Feldt	.140	17.000	.008		

	Lower-bound	.140	17.000	.008		
device * location	Sphericity Assumed	.005	2	.003	.525	.596
	Greenhouse-Geisser	.005	1.861	.003	.525	.584
	Huynh-Feldt	.005	2.000	.003	.525	.596
	Lower-bound	.005	1.000	.005	.525	.478
device * location * order	Sphericity Assumed	.007	2	.004	.763	.474
	Greenhouse-Geisser	.007	1.861	.004	.763	.466
	Huynh-Feldt	.007	2.000	.004	.763	.474
	Lower-bound	.007	1.000	.007	.763	.394
device * location * armgroup	Sphericity Assumed	.022	2	.011	2.283	.117
	Greenhouse-Geisser	.022	1.861	.012	2.283	.122
	Huynh-Feldt	.022	2.000	.011	2.283	.117
	Lower-bound	.022	1.000	.022	2.283	.149
Error(device*location)	Sphericity Assumed	.162	34	.005		
	Greenhouse-Geisser	.162	31.638	.005		
	Huynh-Feldt	.162	34.000	.005		
	Lower-bound	.162	17.000	.010		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.

Intercept	.454	1	.454	19.817	.000
order	.011	1	.011	.487	.495
armgroup	.028	1	.028	1.203	.288
Error	.390	17	.023		

GLM BY armquart WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2
	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
armquart	1.00	5
	2.00	5
	3.00	5
	4.00	5

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.005	2	.003	1.216	.311
	Greenhouse-Geisser	.005	1.906	.003	1.216	.310
	Huynh-Feldt	.005	2.000	.003	1.216	.311
	Lower-bound	.005	1.000	.005	1.216	.287
device * order	Sphericity Assumed	.001	2	.000	.169	.845
	Greenhouse-Geisser	.001	1.906	.000	.169	.835
	Huynh-Feldt	.001	2.000	.000	.169	.845
	Lower-bound	.001	1.000	.001	.169	.686
device * armquart	Sphericity Assumed	.025	6	.004	1.929	.108
	Greenhouse-Geisser	.025	5.717	.004	1.929	.113
	Huynh-Feldt	.025	6.000	.004	1.929	.108

	Lower-bound	.025	3.000	.008	1.929	.168
Error(device)	Sphericity Assumed	.066	30	.002		
	Greenhouse-Geisser	.066	28.583	.002		
	Huynh-Feldt	.066	30.000	.002		
	Lower-bound	.066	15.000	.004		
location	Sphericity Assumed	.002	1	.002	.254	.621
	Greenhouse-Geisser	.002	1.000	.002	.254	.621
	Huynh-Feldt	.002	1.000	.002	.254	.621
	Lower-bound	.002	1.000	.002	.254	.621
location * order	Sphericity Assumed	1.932E-7	1	1.932E-7	.000	.996
	Greenhouse-Geisser	1.932E-7	1.000	1.932E-7	.000	.996
	Huynh-Feldt	1.932E-7	1.000	1.932E-7	.000	.996
	Lower-bound	1.932E-7	1.000	1.932E-7	.000	.996
location * armquart	Sphericity Assumed	.021	3	.007	.770	.528
	Greenhouse-Geisser	.021	3.000	.007	.770	.528
	Huynh-Feldt	.021	3.000	.007	.770	.528
	Lower-bound	.021	3.000	.007	.770	.528
Error(location)	Sphericity Assumed	.136	15	.009		
	Greenhouse-Geisser	.136	15.000	.009		
	Huynh-Feldt	.136	15.000	.009		
	Lower-bound	.136	15.000	.009		
device * location	Sphericity Assumed	.005	2	.002	.512	.604
	Greenhouse-Geisser	.005	1.754	.003	.512	.581

	Huynh-Feldt	.005	2.000	.002	.512	.604
	Lower-bound	.005	1.000	.005	.512	.485
device * location * order	Sphericity Assumed	.007	2	.003	.693	.508
	Greenhouse-Geisser	.007	1.754	.004	.693	.491
	Huynh-Feldt	.007	2.000	.003	.693	.508
	Lower-bound	.007	1.000	.007	.693	.418
device * location * armquart	Sphericity Assumed	.042	6	.007	1.460	.225
	Greenhouse-Geisser	.042	5.263	.008	1.460	.235
	Huynh-Feldt	.042	6.000	.007	1.460	.225
	Lower-bound	.042	3.000	.014	1.460	.265
Error(device*location)	Sphericity Assumed	.142	30	.005		
	Greenhouse-Geisser	.142	26.317	.005		
	Huynh-Feldt	.142	30.000	.005		
	Lower-bound	.142	15.000	.009		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.403	1	.403	16.924	.001
order	.018	1	.018	.761	.397
armquart	.060	3	.020	.845	.491

Error		.357	15	.024		

GLM BY handgroup WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable
1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2
	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
handgroup	1.00	10
	2.00	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.006	2	.003	1.079	.351
	Greenhouse-Geisser	.006	1.991	.003	1.079	.351
	Huynh-Feldt	.006	2.000	.003	1.079	.351
	Lower-bound	.006	1.000	.006	1.079	.314
device * order	Sphericity Assumed	.000	2	.000	.089	.915
	Greenhouse-Geisser	.000	1.991	.000	.089	.915
	Huynh-Feldt	.000	2.000	.000	.089	.915
	Lower-bound	.000	1.000	.000	.089	.769
device * handgroup	Sphericity Assumed	.004	2	.002	.770	.471
	Greenhouse-Geisser	.004	1.991	.002	.770	.470
	Huynh-Feldt	.004	2.000	.002	.770	.471
	Lower-bound	.004	1.000	.004	.770	.392
Error(device)	Sphericity Assumed	.087	34	.003		
	Greenhouse-Geisser	.087	33.841	.003		
	Huynh-Feldt	.087	34.000	.003		
	Lower-bound	.087	17.000	.005		
location	Sphericity Assumed	.005	1	.005	.507	.486
	Greenhouse-Geisser	.005	1.000	.005	.507	.486

	Huynh-Feldt	.005	1.000	.005	.507	.486
	Lower-bound	.005	1.000	.005	.507	.486
location * order	Sphericity Assumed	.000	1	.000	.051	.823
	Greenhouse-Geisser	.000	1.000	.000	.051	.823
	Huynh-Feldt	.000	1.000	.000	.051	.823
	Lower-bound	.000	1.000	.000	.051	.823
location * handgroup	Sphericity Assumed	.004	1	.004	.452	.511
	Greenhouse-Geisser	.004	1.000	.004	.452	.511
	Huynh-Feldt	.004	1.000	.004	.452	.511
	Lower-bound	.004	1.000	.004	.452	.511
Error(location)	Sphericity Assumed	.153	17	.009		
	Greenhouse-Geisser	.153	17.000	.009		
	Huynh-Feldt	.153	17.000	.009		
	Lower-bound	.153	17.000	.009		
device * location	Sphericity Assumed	.006	2	.003	.631	.538
	Greenhouse-Geisser	.006	1.730	.004	.631	.517
	Huynh-Feldt	.006	2.000	.003	.631	.538
	Lower-bound	.006	1.000	.006	.631	.438
device * location * order	Sphericity Assumed	.009	2	.004	.855	.434
	Greenhouse-Geisser	.009	1.730	.005	.855	.421
	Huynh-Feldt	.009	2.000	.004	.855	.434
	Lower-bound	.009	1.000	.009	.855	.368
device * location *	Sphericity Assumed	.009	2	.004	.851	.436

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
handgroup	Greenhouse-Geisser	.009	1.730	.005	.851	.422
	Huynh-Feldt	.009	2.000	.004	.851	.436
	Lower-bound	.009	1.000	.009	.851	.369
Error(device*location)	Sphericity Assumed	.175	34	.005		
	Greenhouse-Geisser	.175	29.409	.006		
	Huynh-Feldt	.175	34.000	.005		
	Lower-bound	.175	17.000	.010		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.470	1	.470	20.011	.000
order	.007	1	.007	.313	.583
handgroup	.018	1	.018	.764	.394
Error	.399	17	.023		

GLM BY handquart WITH order

Within-Subjects Factors

Measure: MEASURE_1

device	location	Dependent Variable

1	1	TMrtmTRAP2
	2	TMctmTRAP2
2	1	TMrttTRAP2
	2	TMcttTRAP2
3	1	TMdummyTRAP
	2	TMrollTRAP2

Between-Subjects Factors

		N
handquart	1.00	3
	2.00	7
	3.00	5
	4.00	5

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
device	Sphericity Assumed	.006	2	.003	1.095	.347
	Greenhouse-Geisser	.006	1.987	.003	1.095	.347
	Huynh-Feldt	.006	2.000	.003	1.095	.347

	Lower-bound	.006	1.000	.006	1.095	.312
device * order	Sphericity Assumed	.000	2	.000	.084	.920
	Greenhouse-Geisser	.000	1.987	.000	.084	.919
	Huynh-Feldt	.000	2.000	.000	.084	.920
	Lower-bound	.000	1.000	.000	.084	.776
device * handquart	Sphericity Assumed	.013	6	.002	.852	.541
	Greenhouse-Geisser	.013	5.960	.002	.852	.540
	Huynh-Feldt	.013	6.000	.002	.852	.541
	Lower-bound	.013	3.000	.004	.852	.487
Error(device)	Sphericity Assumed	.078	30	.003		
	Greenhouse-Geisser	.078	29.798	.003		
	Huynh-Feldt	.078	30.000	.003		
	Lower-bound	.078	15.000	.005		
location	Sphericity Assumed	.004	1	.004	.465	.505
	Greenhouse-Geisser	.004	1.000	.004	.465	.505
	Huynh-Feldt	.004	1.000	.004	.465	.505
	Lower-bound	.004	1.000	.004	.465	.505
location * order	Sphericity Assumed	.001	1	.001	.103	.753
	Greenhouse-Geisser	.001	1.000	.001	.103	.753
	Huynh-Feldt	.001	1.000	.001	.103	.753
	Lower-bound	.001	1.000	.001	.103	.753
location * handquart	Sphericity Assumed	.025	3	.008	.948	.443
	Greenhouse-Geisser	.025	3.000	.008	.948	.443

	Huynh-Feldt	.025	3.000	.008	.948	.443
	Lower-bound	.025	3.000	.008	.948	.443
Error(location)	Sphericity Assumed	.132	15	.009		
	Greenhouse-Geisser	.132	15.000	.009		
	Huynh-Feldt	.132	15.000	.009		
	Lower-bound	.132	15.000	.009		
device * location	Sphericity Assumed	.006	2	.003	.613	.548
	Greenhouse-Geisser	.006	1.785	.003	.613	.531
	Huynh-Feldt	.006	2.000	.003	.613	.548
	Lower-bound	.006	1.000	.006	.613	.446
device * location * order	Sphericity Assumed	.009	2	.004	.948	.399
	Greenhouse-Geisser	.009	1.785	.005	.948	.391
	Huynh-Feldt	.009	2.000	.004	.948	.399
	Lower-bound	.009	1.000	.009	.948	.346
device * location * handquart	Sphericity Assumed	.042	6	.007	1.467	.223
	Greenhouse-Geisser	.042	5.356	.008	1.467	.231
	Huynh-Feldt	.042	6.000	.007	1.467	.223
	Lower-bound	.042	3.000	.014	1.467	.264
Error(device*location)	Sphericity Assumed	.142	30	.005		
	Greenhouse-Geisser	.142	26.778	.005		
	Huynh-Feldt	.142	30.000	.005		
	Lower-bound	.142	15.000	.009		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.469	1	.469	17.919	.001
order	.007	1	.007	.267	.613
handquart	.025	3	.008	.316	.814
Error	.392	15	.026		

Appendix E – Qualitative Responses

Correlations for qualitative responses

Correlations

		familiarity	dificulty	comfort	device	location
familiarity	Pearson Correlation	1	.340[**]	.409[**]	-.792[**]	-.288[**]
	Sig. (2-tailed)		.001	.000	.000	.004
	N	100	100	100	100	100
difficulty	Pearson Correlation	.340[**]	1	.808[**]	-.434[**]	-.094
	Sig. (2-tailed)	.001		.000	.000	.351
	N	100	100	100	100	100
comfort	Pearson Correlation	.409[**]	.808[**]	1	-.400[**]	-.173
	Sig. (2-tailed)	.000	.000		.000	.085
	N	100	100	100	100	100
device	Pearson Correlation	-.792[**]	-.434[**]	-.400[**]	1	.327[**]
	Sig. (2-tailed)	.000	.000	.000		.001
	N	100	100	100	100	100
location	Pearson Correlation	-.288[**]	-.094	-.173	.327[**]	1
	Sig. (2-tailed)	.004	.351	.085	.001	
	N	100	100	100	100	100

**. Correlation is significant at the 0.01 level (2-tailed).