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Reliability of Sixteen Balance Tests in Individuals with Down Syndrome

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RELIABILITY OF SIXTEEN BALANCE TESTS IN INDIVIDUALS WITH DOWN SYNDROME

by

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GRADUATE COMMITTEE APPROVAL

of a dissertation submitted by

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This dissertation has been read by each member of the following graduate committee and by majority vote has been found to be satisfactory.

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As chair of the candidate's graduate committee, I have read the dissertation of Romina Villamonte in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

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ABSTRACT

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WITH DOWN SYNDROME

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The purpose of this study was to determine the reliability of sixteen balance tests in individuals with Down syndrome (DS). The following tests were performed on 21 participants with DS, aged 5-31 years of age; standing test on firm and soft surfaces with the eyes opened and closed, a balance subset of the Bruininks-Oseretsky test, full turn, timed-up-and-go test, forward reach, and sit-to-stand. Each participant completed all 16 assessments twice on one day and then again on a subsequent day for a total of four trials. Seven tests had reliability coefficients greater than 0.55; one-leg stand on floor (0.76), on balance beam with eyes opened (0.62) and eyes closed (0.69), heel-to-toe walk on balance beam (0.63), straight line walk on floor (0.57), and CGS on firm (0.63) and soft (0.86) surfaces with eyes opened. We recommend these seven tests for use in clinical and non clinical settings.

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RELIABILITY OF SIXTEEN BALANCE TESTS IN INDIVIDUALS WITH DOWN SYNDROME

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ABSTRACT

The purpose of this study was to determine the reliability of sixteen balance tests in individuals with Down syndrome (DS). The following tests were performed on 21 participants with DS, aged 5-31 years of age; standing test on firm and soft surfaces with the eyes opened and closed, the balance subset of the Bruininks-Oseretsky test, full turn, timed-up-and-go test, forward reach, and sit-to-stand. Each participant completed all 16 assessments twice on one day and then again on a subsequent day for a total of four sessions. Seven tests had reliability coefficients greater than 0.55; one-leg stand on floor (0.76), on balance beam with eyes opened (0.62) and eyes closed (0.69), heel-to-toe walk on balance beam (0.63), straight line walk on floor (0.57), and CGS on firm (0.63) and soft (0.86) surfaces with eyes opened. We recommend these seven tests for use in clinical and non clinical settings.

Key words. Balance, reliability, Down syndrome

INTRODUCTION

Down syndrome (DS) is one of the most prevalent chromosomal disorders, occurring in 1 out of every 800 births (National Down Syndrome Society, 2008). There are more than 350,000 individuals with DS in the USA alone (NDSS, 2008). Individuals with DS participate in educational, vocational, social and recreational aspects of our communities (NDSS, 2008). Today, more than ever before, teens and adults with DS graduate from high school and obtain a college education (NDSS, 2008). Many adults with DS are employed and live independently. Individuals with DS have opportunities to develop their abilities and talents, which lead to their dreams becoming a reality (NDSS, 2008).

A common characteristic among individuals with DS is that they have some degree of mental retardation (Hayes & Batshaw, 1993). The most cited weakness in individuals with mental retardation is a lack of dynamic balance (Boswell, 1991). Dynamic balance is necessary to move from one position to another, and to move freely in the community, whereas static balance is the ability to maintain a bodily position (Berg, Maki, Williams, Holliday, & Wood-Dauphinee, 1992). Individuals with DS rank lower in their balance performance when compared to the general population or other mentally handicapped individuals (Tsimaras & Fotiadou, 2004). Individuals with DS have a significant delay in motor skills and balance development that persist through adulthood (Wang & Ju, 2002). Some characteristics of DS that affect balance include hypotonia, strength deficits and a small cerebellum and brain stem (Angelopoulou, Tsimaras, Christoulas, Kokaridas, & Mandroukas, 1999; Carmeli, Ayalon, Barchad, Sheklow, & Reznick, 2002; Cioni, Cocilovo, Di Pasquale, Araujo, Siqueira, and Bianco, 1994; Connolly & Michael, 1986; Connolly, Morgan, & Russell, 1984; Cowie, 1970; Duger, Bumin, Uyanik, Aki, & Kayihan, 1999; Hayes & Batshaw, 1993; Jobling & Mon-Williams, 2000; Selikowitz, 1997). Hypotonia or strength deficits will lead to poor standing balance, which is associated with an increased risk of falling (Carmeli, Bar-Chad, Lotan, Merrick, & Coleman, 2003; Carmeli, Kessel, Coleman, & Ayalon, 2002).

Having good balance helps maintain an independent lifestyle in individuals with DS. Training programs designed for individuals with DS include creative dancing, movement exploration, jumping, treadmill walking, and ball exercises (Boswell, 1991; Carmeli et al., 2003; Carmeli, Kessel et al., 2002; Tsimaras & Fotiadou, 2004; Wang & Chang, 1997; Wang & Ju, 2002). Results from these studies showed that dynamic balance skills of floor walk and beam walk as well as vertical and horizontal jumps significantly improved with six weeks of jump training; furthermore, a two-month follow-up showed no significant difference in any of the dynamic or jumping skills (Wang & Chang, 1997; Wang & Ju, 2002). Dynamic balance measured on a stabilometer significantly improved in individuals with DS after twelve weeks of training (Tsimaras & Fotiadou, 2004). A timed-up-and-go test in elderly individuals with DS significantly improved with six months of treadmill walking (Carmeli, Kessel, et al., 2002). Other studies have compared children with DS to individuals with and without mental retardation. They all found that children with DS scored lower in balance tests compared to matched children with and without mental retardation (Le Blanc, French, & Shultz, 1977; Spano, Mercuri, Rando, Panto, Gagliano, Henderson, and Guzzetta, 1999;

Vuillerme, 2001). Many studies have tried to identify effective programs designed to improve balance in individuals with DS; however, none have established reliability of the assessment methods to measure balance in individuals with DS (Boswell, 1991; Carmeli, Ayalon et al., 2002; Carmeli et al., 2003; Carmeli, Kessel et al., 2002; Le Blanc et al., 1977; Wang & Ju, 2002). The balance tests used in the previous mentioned studies have moderate to high reliability coefficients in matched children and adults; however, the reliability coefficients of these tests were not measured in individuals with DS (Bohannon, 1994; Boswell, 1991; Bruininks, 1978; Carmeli et al., 2003; Duncan, Weiner, Chandler, & Studenski, 1990).

The reliability of balance assessments in a DS population must be determined to better help guide physical educators, physical therapists and other members of a health care team in assessment, program placement and planning, and performance goals for individuals with motor impairments (Duger et al., 1999; Tan, Parker, & Larkin, 2001). Therefore, the purpose of this study was to determine the reliability of sixteen balance tests in individuals with DS.

METHODS

Subjects

We performed sixteen balance tests on 21 participants, aged 5-31 years of age, with DS who had no physical disability that would impair mobility or uncorrected visual or auditory disability, were able to walk independently, and were able to follow simple instructions. Subjects were recruited from communities in the states of Utah and Nevada through the Utah Down Syndrome Association. All participants had been diagnosed with

DS with mild or moderate retardation. Institutional review board approval was obtained from Brigham Young University prior to collection of data. A signed informed consent was obtained from the parents of each participant before testing was performed.

Procedures

Each participant completed sixteen different balance tests twice on one day and then repeated the assessment twice on a subsequent day for a total of four assessments. Participants completed three trials of each balance test. The two assessments within each day were separated by approximately one hour. The order of the 16 tests varied between the four assessments. The two days of testing were separated by one to seven days. Each participant was tested individually. Each assessment lasted between 25 to 60 minutes and a total of two to three hours per session were spent with each participant to obtain the data. Subjects were tested in an open area relatively free of disturbances and noises. Each subject wore athletic shoes and comfortable clothes.

The preferred leg was determined by asking the participant to pretend to kick a ball three times. We recorded the participant’s preferred leg to ensure the use of the same leg for all the one-leg standing tests.

Tests

The sixteen balance tests used in this study were selected because they have been used by previous researchers to assess balance in individuals with DS (Bohannon, 1994; Boswell, 1991; Bruininks, 1978; Carmeli et al., 2003; Carmeli, Kessel et al., 2002; Duncan et al., 1990; Le Blanc et al., 1977; Mathias, Nayak, & Isaacs, 1986; Tsimaras & Fotiadou, 2004; Vuillerme, 2001; Wang & Chang, 1997; Wang & Ju, 2002). Each test is described below. The overall center of gravity sway (CGS) of each participant was measured during four static tests performed on the NeuroCom Balance Master System (NeuroCom International). The four tests included a standing test with the eyes opened and closed and standing on a soft surface with the eyes opened and closed. The CGS value in degrees per second was recorded when the participant held the position for ten seconds.

Static Tests

Standing test-firm surface (NeuroCom International). The participant stood on a firm surface with their feet parallel, shoulder width apart with their eyes open and their hands at their sides. The participants were instructed to hold as still as possible without taking any steps for ten seconds. The amount of time in seconds the participant could hold the position was recorded. Center of gravity sway was recorded while the participant held the position for 10 seconds.

Standing test-firm surface with eyes closed (NeuroCom International). The participant stood on a firm surface with their feet parallel, shoulder width apart with their eyes closed and their hands at their sides. The participants were instructed to hold as still as possible without taking any steps for ten seconds. The amount of time in seconds the participant could hold the position was recorded. Center of gravity sway was recorded while the participant held the position for 10 seconds.

Standing test-soft surface (NeuroCom International). The participant stood on a soft surface with their feet parallel, shoulder width apart with their eyes open and their hands at their sides. The standard foam block used by NeuroCom, 50 cm by 50 cm by 15 cm was used as a soft surface. The participant was instructed to hold as still as possible without taking any steps for ten seconds. The amount of time in seconds the participant could hold the position was recorded. Center of gravity sway was recorded while the participant held the position for 10 seconds.

Standing test-soft surface with eyes closed (NeuroCom International). The participant stood on a soft surface with their feet parallel, shoulder width apart with their eyes closed and hands at their sides for ten seconds. The standard foam block used by NeuroCom, 50 cm by 50 cm by 15 cm was used as a soft surface. The participant was instructed to hold as still as possible without taking any steps for ten seconds. The amount of time in seconds the participant could hold the position was recorded. Center of gravity sway was recorded while the participant held the position for 10 seconds.

Other Tests

Standing on preferred leg on the floor (Bruininks, 1978). The participant stood on their preferred leg looking forward with their hands at their sides; the knee of the non preferred leg was bent so the lower leg was parallel to the floor. The participant was instructed to maintain this position for as long as they could. The amount of time in seconds the participant could hold the position was recorded. The maximum score was 10 seconds.

Standing on preferred leg on a balance beam (Bruininks, 1978). The participant stood on their preferred leg on a 4-inch wide balance beam, looking forward with their hands at their sides, and the knee of the non preferred leg was bent so the lower leg was parallel to the beam. The participant was instructed to maintain this position for as long as they could. The amount of time in seconds the participant could hold this position was recorded. The maximum score was 10 seconds.

Standing on preferred leg on a balance beam with eyes closed (Bruininks, 1978). The participant stood on their preferred leg on a 4-inch wide balance beam with their eyes closed and hands at their sides and the knee of the non-preferred leg was bent so the lower leg was parallel to the beam. The participant was instructed to maintain this position for as long as they could. The amount of time in seconds the participant could hold this position was recorded. The maximum score was 10 seconds.

Walking forward on a balance beam (Bruininks, 1978). The participant was instructed to walk forward on a 10 feet long, 4-inch wide balance beam with a normal walking stride. The number of consecutive steps completed on the balance beam was recorded as the score for this test. Maximum score was six steps.

Walking forward on a walking line (Bruininks, 1978). The participant was instructed to walk forward on a walking line with a normal walking stride and with their hands at their sides. The walking line was made using 5 cm wide masking tape taped to the floor. The number of consecutive steps completed on the walking line was recorded as the score for this test. Maximum score was six steps.

Walking forward heel-to-toe on a balance beam (Bruininks, 1978). The participant was instructed to walk forward on a 10 feet long, 4-inch wide balance beam heel-to-toe with hands at their sides. The number of consecutive steps completed on the balance beam was recorded as the score for this test. Maximum score was six heel-to-toe steps.

Walking forward heel-to-toe on a walking line (Bruininks, 1978). The participant was instructed to walk forward on the walking line, heel-to-toe with their hands on their sides. The walking line was made using 5 cm wide masking tape taped to the floor. The number of consecutive steps completed on the walking line was recorded as the score for this test. Maximum score was six heel-to-toe steps.

Stepping over response speed stick on a balance beam (Bruininks, 1978). The participant walked forward on 4-inch wide balance beam, stepping over a response speed stick held in the middle of the beam by the examiner. A broomstick was used as the response stick. The height of the response stick was one inch below the patella of the participant. The participant walked on the beam with a normal stride with his/her hands at their sides. The participants score was recorded as pass (score of 1) or fail (score of 0). A passing score was given if the participant stepped over the response stick without touching it and placed the next step on the balance beam. A failing grade was given if the participant touched the response stick or if they went around the stick.

Time up-and-go test (Carmeli et al., 2003; Mathias et al., 1986). This test was used to measure a mixture of four different locomotor tasks. Participants began in the seated position. Participants stood, walked 9 m, turned around, returned to the chair, turned around, and sat down. Time to complete the task was recorded in seconds using a manual stopwatch.

Full turn (Carmeli et al., 2003). The 360º turn test measured the ability to perform a full turn. The test was performed twice, once in each direction. The number of steps taken and the amount of time in seconds to complete full turn in place was recorded.

Forward reach (Carmeli et al., 2003; Duncan et al., 1990). The forward reach test measured margin of stability or the ability to shift center of mass by reaching forward as far as possible without taking a step. The participant was asked to stand up straight, make a fist holding a dry erase marker, and extend their right or left arm forward parallel to the whiteboard. The white board was fixed on the wall and used to make the measurements. The participant was asked to reach forward as far as possible without taking a step, losing balance, or touching the white board. As they reached, they marked the white board with the dry erase pen. Functional reach was defined as the length between starting and ending positions.

Sit-to-stand test (Carmeli et al., 2003). From a seated position, the participant got up from an armless chair, stood, and then sat down again. The height of the chair depended on the individual's height. Four chair heights were available for the test, 30 cm, 35 cm, 41 cm, and 46 cm. The participant sat on the chair with their feet flat on the ground with their knees bent at a 90° angle. Their feet did not change position during the test. This was repeated for 20 seconds. The test measures the ability to transfer body weight upright and then down by use of the knee extensor and lower back muscles. The number of sit-to-stands completed in 20 seconds were recorded.

Data Analysis

Three trials of each test were performed during each of the four assessments. For each assessment the best value (maximum or minimum) of the three trials was used as the observed value, which is the accepted practice when testing. An analysis of variance determined that there were no significant differences in the observed scores of the four assessments for each of the 16 balance tests for within subject. Therefore, the observed values from all four assessments were pooled together to establish within and between subject variance to compute reliability coefficients. Statistical analysis of the data obtained from the four assessments of the battery of 16 tests was performed using the interclass correlation coefficient (ICC) to determine reliability of each test. We tested all data regardless of gender or age of the participant since the ICC calculation is based on an analysis of variance that estimates the amount of variance within a subject relative to the variance between subjects. Generally tests with ICC values of less than 0.5, between 0.5 and 0.75, and greater that 0.75 can be considered as having poor, moderate, and good reliability, respectively (Portney, 2000).

RESULTS

Characteristics of the 21 participants are shown in Table 1. The results of the 16 balance assessments revealed varying degrees of reliability (Table 2). Center of gravity sway and time were recorded for each of the four static tests. Time and steps taken to complete a full turn were recorded on the full turn test to the right and to the left. Therefore, there were 23 reliability coefficients for the 16 balance assessments that were used in this study. Reliability coefficients could not be calculated for standing on a firm or soft surface because all participants were able to complete 10 seconds in each of the two tests. Eight tests had negative ICC values, indicating that the variance within each participant was greater than the variance between participants, thus making the test unreliable. Six of the balance assessments had ICC values of less than 0.55 and are therefore considered to have poor reliability. The tests with negative ICC were considered to be unreliable. The mean score, standard deviation, and reliability value for each test are shown in Table 2.

Of the 21 participants, one was unable to complete the forward reach test. Data from one subject was dropped for the full turn test due to recording errors. The CGS of the first five subjects was tested using a Biodex Balance System, but the results varied depending on how close to the center of the plate the participant was standing. Because it was hard for some of the participants to always stand on the center of the plate, we used the NeuroCom Balance Master System to test the CGS on the remaining 16 participants. Therefore, only 16 participants completed the CGS tests on the four static measurements using the NeuroCom Balance Master System.

DISCUSSION

To the best of our knowledge, this study is the first to report reliability coefficients for a battery of tests commonly used to assess balance in normal individuals and individuals with DS. The results of our study indicate that seven balance assessments (Table 3) have moderate to good reliability and can therefore be used as evaluative tools in individuals with DS. Five of the seven tests that we found to be reliable in individuals with DS (Table 3) are part of the balance subset of the Bruininks-Oseretsky test (Bruininks, 1978). The test-retest reliability of the balance subset of the Bruininks-Oseretsky test is 0.56 in children aged 4 to 14 years old (Bruininks, 1978). Our results show that the test-retest reliability coefficient of all eight tests included in the balance subtest of the Bruininks-Oseretsky test in individuals with DS is 0.50. Our results also show that the five tests that are part of the balance subset of the Bruininks-Oseretsky test that are included in the seven assessments we recommend for use in individuals with DS have an average reliability of 0.65 (Table 3).

Based on the results of this study, we recommend that only five of the eight assessments included in the balance subset of the Bruininks-Oseretsky test need to be performed when measuring balance in individuals with DS. The advantage of using these five tests is that minimal equipment is required and they can be performed in most clinical and non clinical settings. Participants had difficulty performing the remaining three tests of the balance subset of the Bruininks-Oseretsky test that were unreliable. When performing the stepping over response speed stick on a balance beam, participants would often try to go around the stick, kick the stick, or step on the floor instead of the beam. During the heel-to-toe walking on a walking line, participants stepped to the side or they were not able to maintain the position from one step to the next. While walking on the balance beam, some participants took one step on the beam and the other on the floor. We noticed that some of the older participants were able to complete the maximum number of steps during all four trials of the walking tests.

Previous studies measuring balance in children with DS used only five of the eight items found in the Bruininks-Oseretsky test since the other tests were too difficult for the children with DS to perform (Wang & Chang, 1997; Wang & Ju, 2002). These five tests include duration standing on preferred leg on floor and balance beam, number of steps of walking forward on walking line and balance beam, and number of steps of walking forward heel-to-toe on balance beam (Wang & Chang, 1997; Wang & Ju, 2002). We found that four of these five tests that were previously used in children with DS have moderate reliability coefficients (see Table 3).

Two of the seven assessments that we recommend for use in individuals with DS require the use of the NeuroCom System, which estimates CGS. The two tests performed on the NeuroCom System; standing on soft surface with eyes open and standing on firm surface with eyes open, have reliability coefficients of 0.86 and 0.63, respectively. Although these two tests are the most reliable, a NeuroCom System may not be available for use in some clinical settings, much less in non clinical settings. When available it should be included in the assessment of balance. A force plate with ability to measure center of pressure movement may be used if available.

Several of the tests should not be used to assess balance in individuals with DS. The standing on a firm and soft surface with the eyes open are not sensitive balance assessments since every participant was able to achieve the maximum score. Increasing the duration of simple tests, such as standing on a firm or soft surface, may make the test more effective in measuring balance. However, performance scores of simple tests of longer duration may reflect limitations of attention rather than balance.

Eight of the sixteen tests had negative ICC values (Table 2) and thus should not be used to assess balance in individuals with DS. These eight tests had a high within participant variance component (Table 2) indicating that participants were not consistent in their performance across trials or assessments. One explanation for the high within variance component is that the test either elicits fear or includes multiple tasks.

Participants often expressed fear of falling when standing with their eyes closed. Tests that included multiple tasks present a greater physical and cognitive challenge to participants. For example, when participants were performing the timed-up-and-go and the full turn tests, they would sometimes walk or turn quickly and other times they would perform these tests very slowly. In the full turn test, participants often varied the number of steps taken during the turn. During the sit to stand test some of the participants would stop halfway because they were tired of standing and sitting.

Some of the assessments that we used in this study have a moderate to good reliability coefficient in an elderly population. These tests include the full turn test, the forward reach test, and time-up-and-go test, which have reliability coefficients of 0.83-0.96, 0.56-0.65, and 0.91 respectively (Carmeli et al., 2003; de Vreede, Samson, van Meeteren, Duursma, & Verhaar, 2006). Our results show that the reliability coefficients of these three tests range from negative values to 0.53 in a DS population (see Table 2). We observed that during the forward reach test, some of the participants did not fully understand the concept of reaching forward without taking a step. Some of the participants in this study were consistent between trials while others performed better on the second day of testing. Our results show an ICC value of 0.53. We suggest a familiarization period prior to performing tests such as this that may be difficult to understand.

Researchers have tried to identify effective programs to improve balance in individuals with DS; however, they have not established the reliability of the assessments used to measure balance (Boswell, 1991; Carmeli, Ayalon et al., 2002; Carmeli et al., 2003; Carmeli, Kessel, et al., 2002; Le Blanc et al., 1977; Wang & Ju, 2002). Unreliable and erroneous assessments of balance misrepresent the individual's abilities and compromises correct interpretation. Unreliable assessments are not able to track progress of individuals who are trying to improve balance. Likewise, unreliable assessments should not be used to determine the success of interventions designed to improve balance. It is important to choose reliable tests that have little error associated with the scores (Ulrich, 2000).

Studies have shown that children with DS can improve their balance with physical activity (Boswell, 1991; Le Blanc et al., 1977; Wang & Ju, 2002). With reliable balance assessments, future research can possibly determine the effect of various forms of physical activity on balance on individuals with DS. Normative values for males and females of different age groups of individuals with DS should also be established. These guidelines and norms would allow physical educators, physical therapists, and others to make appropriate decisions about interventions, program placements and planning, and goals based on the results of an assessment (Duger et al., 1999; Tan et al., 2001).

CONCLUSION

The objective of this study was to determine reliability of sixteen tests used to assess balance in individuals with DS. We found seven tests to be reliable; standing on preferred leg on a balance beam with eyes opened and closed, standing on preferred leg on the floor, walking forward heel-to-toe on a balance beam, walking forward on a walking line, CGS values on standing tests on soft and firm surface with eyes opened. These seven tests may assist professionals in determining treatment effectiveness, goals, and improvement in individuals with DS. The set of tests that we found to be reliable is easy to administer and safe for use in individuals with DS. When a NeuroCom System is unavailable, the remaining five practical and easy to perform tests can be used to reliably assess balance in individuals with DS.

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Table 1

Descriptive Statistics of Participants

Subjects	N	Age	Weight (kg)	Height (m)	BMI (kg/m^2)
Male	10	17.8 ± 11.3 (5 - 31)	56.9 ± 34.6 (15.9 - 104.4)	1.36 ± 0.32 (0.94 – 1.65)	26.4 ± 8.1 (16.2 - 40.8)
Female	11	16.0 ± 7.0 (8 - 29)	48.6 ± 23.3 (21.8 – 111.0)	1.39 ± 0.11 (1.12 – 1.54)	24.4 ± 9.5 (17.4 - 51.4)
Total	21	16.8 ± 9.1 (5 - 31)	52.5 ± 28.8 (15.9 – 111.0)	1.38 ± 0.23 (0.94 – 1.65)	25.4 ± 8.7 (16.2 - 51.4)

Note. Values are means ± *SD* (range)

Table 2

Reliability Coefficients, Means, Standard Deviation, Between Variance, Within Variance, and ICC for Each of the Sixteen Balance Items

Item	Units	N	Mean	Standard Deviation	Variance		ICC
					Between	Within	
Standing test - firm surface with eyes closed	sec	21	9.48	1.17	0.367	3.036	-7.26
Standing test - firm surface with eyes closed	º/sec	16	1.11	1.2	0.807	0.533	0.34
Standing test - soft surface with eyes closed	sec	21	9.57	1.36	0.27	1.167	-3.32
Standing test - soft surface with eyes closed	º/sec	16	2.02	1.03	0.606	0.329	0.46
Standing test - soft surface with eyes opened	sec	21	10.0	0	0	0	-
Standing test - soft surface with eyes opened	º/sec	16	1.43	1.09	1.115	0.159	0.86
Standing test - firm surface with eyes opened	sec	21	10.0	0	0	0	-
Standing test - firm surface with eyes opened	º/sec	16	1.04	1.08	1.103	0.408	0.63
Standing on preferred leg on a balance beam	sec	21	4.11	3.03	8.737	3.301	0.62
Standing on preferred leg on a balance beam with eyes closed	sec	21	1.38	1.97	3.727	1.159	0.69
Standing on preferred leg on the floor	sec	21	4.4	3	8.22	1.99	0.76
Walking forward on a walking line	steps	21	5.49	1.25	1.488	0.644	0.57
Walking forward on a balance beam	steps	21	5.0	1.14	1.16	0.757	0.35
Walking forward heel-to-toe on a walking line	steps	21	2.81	1.97	3.176	1.963	0.38
Walking forward heel-to-toe on a balance beam	steps	21	2.25	1.81	2.975	1.109	0.63
Stepping over response stick on a balance beam	0/1	21	0.83	0.27	0.038	0.126	-2.28
Timed up and go test	sec	21	18.85	2.76	6.124	7.062	-0.15
Full turn - left	steps	21	4.1	0.58	0.163	0.533	-2.16
Full turn - left	sec	20	2.3	0.71	0.333	0.231	0.31
Full turn - right	steps	21	4.3	0.5	0.158	0.415	-1.62
Full turn - right	sec	20	2.1	0.5	0.121	0.306	-1.53
Forward Reach	cm	20	19	7.9	57.545	27.241	0.53
Sit-to-stand test	total	21	7.65	1.22	1.189	1.372	-0.15

Note. ICC: Interclass Reliability Coefficient

Table 3

The Seven Balance Assessments Recommended for use in Individuals with Down Syndrome

Item	Units	N	Mean	Standard Deviation	Variance Between	Variance Within	ICC
Standing test - soft surface with eyes opened	°/sec	16	1.43	1.09	1.12	0.16	0.86
Standing on preferred leg on the floor *	sec	21	4.40	3.00	8.22	1.99	0.76
Standing on preferred leg on a balance beam with eyes closed	sec	21	1.38	1.97	3.73	1.16	0.69
Standing test - firm surface with eyes opened *	°/sec	16	1.04	1.08	1.10	0.41	0.63
Walking forward heel-to-toe on a balance beam *	steps	21	2.25	1.81	2.98	1.11	0.63
Standing on preferred leg on a balance beam *	sec	21	4.11	3.03	8.74	3.30	0.62
Walking forward on a walking line *	steps	21	5.49	1.25	1.49	0.64	0.57

Note. * denotes the five assessments included in the balance subset of the Bruininks-Oseretsky test (Bruininks, 1978).

Appendix A

Prospectus

Chapter 1

Introduction

For centuries, Down syndrome (DS) individuals have been indirectly referred to in the arts. In the 16th century painting "The Adoration of The Christ Child", an angel is represented with DS features (Dobson, 2003; Selikowitz, 1997b). It was not until 1866 that a physician, John Langdon Down, first described the characteristic features of individuals with DS (Down, 1866). In 1959, Jérôme Lejeune, a French pediatrician and geneticist discovered that DS was caused by trisomy 21, a chromosomal anomaly (Hayes & Batshaw, 1993; Lejeune, Gautier, & Turpin, 1959; Lejeune, Turpin, & Gautier, 1959a, 1959b; Selikowitz, 1997b).

Down syndrome is one of the most prevalent chromosomal disorders, occurring in 1 out of every 800 births. There are more than 350,000 individuals with DS in the USA alone (NDSS). Individuals with DS participate in educational, vocational, social and recreational aspects of our communities (NDSS). Today, more than ever before, teens and adults with DS graduate from high school and obtain a college education. Many adults with DS are employed and live independently. Individuals with DS have opportunities to develop their abilities and talents, which lead to their dreams becoming a reality (NDSS).

Individuals with DS rank lower in their balance performance when compared to the general population or other mentally handicapped individuals (Tsimaras & Fotiadou, 2004). The most cited weakness in individuals with mental retardation is a lack of dynamic balance (Boswell, 1991). Individuals with DS have a significant delay in motor skills and balance development; these problems are present during childhood and adulthood (W. Y. Wang & Ju, 2002). Some characteristics of DS that affect balance, include hypotonia, strength deficits and a small cerebellum and brain stem (Angelopoulou, Tsimaras, Christoulas, Kokaridas, & Mandroukas, 1999; Carmeli, Ayalon, Barchad, Sheklow, & Reznick, 2002; Cioni et al., 1994; Connolly & Michael, 1986; Connolly, Morgan, & Russell, 1984; Cowie, 1970; Duger, Bumin, Uyanik, Aki, & Kayihan, 1999; Hayes & Batshaw, 1993; Jobling & Mon-Williams, 2000; Selikowitz, 1997b).

Balance is required to do everyday activities, to maintain a position, to be able to move from one position to another, and to move freely in the community (K. O. Berg, Maki, Williams, Holliday, & Wood-Dauphinee, 1992). Having good balance will help maintain an independent lifestyle in individuals with DS. A lack of balance due to hypotonia or strength deficits will lead to poor standing balance, which is associated with an increased risk of falling (Carmeli, Bar-Chad, Lotan, Merrick, & Coleman, 2003; Carmeli, Kessel, Coleman, & Ayalon, 2002). It is believed that older adults with DS have an increased morbidity due to an impaired physical development and sedentary lifestyle (Carmeli et al., 2003; Carmeli, Kessel et al., 2002). Postural control consists of sensory systems, motor system, and multiple neural systems. Many studies have tried to identify effective programs that might improve balance in individuals with DS; however, none have established reliability of the assessment methods to measure balance in DS individuals (Boswell, 1991; Carmeli, Ayalon et al., 2002; Carmeli et al., 2003; Carmeli, Kessel et al., 2002; Le Blanc, French, & Shultz, 1977; W. Y. Wang & Ju, 2002). To determine a program's effectiveness in helping individuals with DS improve balance, the reliability of balance assessment tests in a DS population must be determined. It is very important to have a standard assessment guideline for children and adults with mild motor impairments. Assessment guidelines help guide physical therapists and physical educators to make appropriate decisions about the intervention, program placement and planning, and performance goals for individuals with motor impairments (Duger et al., 1999; Tan, Parker, & Larkin, 2001). Determining the reliability of balance assessment tests will help establish a standard assessment guideline in individuals with mild motor impairments.

Statement of Purpose

The primary purpose of this study was to determine the reliability of sixteen balance tests in individuals 5-31 years of age with DS. The secondary purpose of this study was to determine the reliability of center of gravity sway in 4 static balance tests in individuals with DS.

Hypotheses

Null $Hypothesis_1$: None of the balance tests are reliable in assessing balance in individuals with DS.

Alternative $Hypothesis_1$: At least one test is reliable in assessing balance in individuals with DS.

Null Hypothesis$_2$: There is no center of gravity sway reliability in assessing balance in individuals with DS.

Alternative Hypothesis$_2$: At least one test has center of gravity sway reliable in assessing balance in individuals with DS.

Definition of Terms

Balance - “The ability to maintain body equilibrium while stationary or moving” (Bruininks, 1978)

Reliability. “Both the precision of the test as a measuring instrument and the consistency with which the test measures a particular ability” (Bruininks, 1978)

Validity - “The appropriateness, meaningfulness, and usefulness of the specific inferences made from test scores” (*Standards for educational and psychological testing.*, 1985)

Delimitations

Subjects in this study were recruited entirely from the states of Utah and Nevada.

Assumptions

Subjects will put forth their best effort for during each test.

Limitations

This study was limited to a relatively small number of subjects with Down syndrome, 5 to 31 years of age, with various degrees of intellectual and physical disabilities.

Chapter 2

Review of Literature

History of Down Syndrome

Down syndrome (DS) might be the oldest condition related to mental retardation (Hayes & Batshaw, 1993). The earliest recorded representation of DS was painted in about 1515 in Achen, Germany, by an unnamed painter. The painting, “The Adoration of the Christ Child,” was an alter piece in which an angel is represented as having DS features (Dobson, 2003; Selikowitz, 1997b).

Dr. John Langdon Down first described the characteristic features of DS in 1866 (Down, 1866). Although Dr. Down did not understand the cause of the condition, he first thought that DS was a reversion to primate Mongolian ethnic stock (Selikowitz, 1997b). In 1932, P. J. de Waardenburg, a Dutch ophthalmologist, suggested that DS might be caused by a chromosomal abnormality (Selikowitz, 1997b). It was not until 1959 that Jérôme Lejeune, a pediatrician and geneticist, specializing in treating children with DS, demonstrated that they had an extra chromosome 21 (Hayes & Batshaw, 1993; Lejeune, Gautier et al., 1959; Lejeune, Turpin et al., 1959a, 1959b; Selikowitz, 1997b). After the first discovery of an extra chromosome 21 using skin biopsies, Dr. Lejeune found that all individuals with DS characteristics had a third chromosome 21 (Lejeune, Gautier et al., 1959; Lejeune, Turpin et al., 1959a, 1959b).

Incidence of Down syndrome. Down syndrome is one of the most prevalent chromosomal disorders (Hayes & Batshaw, 1993). There are about 350,000 individuals with DS in the United States alone (NDSS). This birth defect occurs in about 1 in every 800 births and it is common in all ethnic groups (Hayes & Batshaw, 1993; Selikowitz, 1997b). The prevalence of babies born with DS increases as the mother's age increases, especially when the mother is over 35 years of age. However, the percentage of pregnancies in this age group is less than 10% in most developed countries (Selikowitz, 1997b).

Chromosomal error in Down syndrome. Each cell in the body has 46 chromosomes (23 pairs) made up of genes. Dr. Lejeune found that infants with DS had a total of 47 chromosomes, with an extra chromosome in pair 21, (see Figure 1) referred to as trisomy 21.(Lejeune, Gautier et al., 1959) The additional chromosome (and genes) causes an excessive amount of certain proteins to be formed in the cell (Selikowitz, 1997a). During fetal development, the cells divide at a slower rate compared to a normal fetus. This results in fewer cells in the body and a smaller baby. The migration of cells to form different parts of the body is disrupted, particularly in the brain. Since the brain has less brain cells and different formations, individuals with DS will learn at a slower rate (Hayes & Batshaw, 1993).

Classifications of Down Syndrome

The majority (95%) of individuals with DS have an extra chromosome 21 in every cell of their body (Cunningham, 1996b; Hayes & Batshaw, 1993; Selikowitz, 1997a). This is caused by one of the parents giving two chromosome 21 to the child through the sperm or egg. When the sperm or egg is formed, a cell from the ovary or testicle divides to form two new cells, each with 23 chromosomes. In individuals with trisomy 21, this division is abnormal and the sperm or egg receives an extra chromosome 21. This process is known as non-disjunction since the pair of chromosome 21 does not divide (Cunningham, 1996b; Selikowitz, 1997a). The new pair of cells formed from the testicle or ovary are different. One has an extra chromosome 21 and the other is missing chromosome 21, which cannot survive and it disintegrates. The exact cause of non-disjunction is unknown, yet it is likely caused by many factors (Selikowitz, 1997a).

In about 4% of individuals with DS, an extra part of chromosome 21 is present (Cunningham, 1996b; Hayes & Batshaw, 1993; Selikowitz, 1997a). The process of one chromosome sticking to another is known as translocation (Selikowitz, 1997a). The small top portion of chromosome 21 and another chromosome break off, and the two remaining portions stick to each other. Only certain chromosomes, the most common being 13, 14, 15 or 22, are involved with translocation of part of chromosome 21 (see Figure 2). It is not known why translocation takes place, but it is known that parental age at time of conception is not a factor.

Mosaicism occurs in less than 1% of DS cases in which there is a whole extra chromosome 21 in only a fraction of their body cells and the rest of their cells are normal (Cunningham, 1996b; Selikowitz, 1997a). The term mosaicism is used since the body cells are like a mosaic made up of normal cells and some with an extra chromosome 21. Individuals with mosaicism DS develop and function closer to a normal range (Selikowitz, 1997a). Individuals with mosaic DS have fewer or less marked features of

DS, they also tend to have higher mental performance and language development than the typical trisomy 21 DS (Cunningham, 1996b).

Level of Severity of Down Syndrome

Mild retardation is described as having an IQ between 75–79 to 50–55 on the Wechsler Intelligence Scale for Children – Revised (WISC-R) with mild deficits in adaptive behavior (Boswell, 1991). Moderate retardation is described as having an IQ between 30–35 to 50-55 with major deficits in adaptive behavior (Boswell, 1991). Severe retardation is described as having an IQ between 20–25 to 30-35.

Characteristics of Down Syndrome

Dr. Down identified less than a dozen characteristics of children with DS (Down, 1866). Since then, over 100 anatomical, physiological, and behavioral characteristics have been defined in individuals with DS (Cunningham, 1996a; Selikowitz, 1997b). Not every individual with DS has all of the characteristics. Many individuals with DS have six to seven characteristics present. Individuals with DS have been described as being clumsy and awkward. They rank low in their performance in assessments of balance and muscle strength (Angelopoulou et al., 1999). The characteristic that is common in all individuals with DS is some degree of intellectual disability (Hayes & Batshaw, 1993; Selikowitz, 1997b).

Children with DS have very mobile joints and low muscular tone (hypotonia) (Angelopoulou et al., 1999; Carmeli, Ayalon et al., 2002; Cioni et al., 1994; Connolly & Michael, 1986; Hayes & Batshaw, 1993; Selikowitz, 1997c). Hypotonia diminishes with age and is less noticeable after they are 10 years of age (Selikowitz, 1997c). Between 5 to 12 years of age, gross-motor skills become more refined. Their joints lose some of their abnormal mobility and they have an increase in muscle tone. After the age of 10, there is a steady improvement in muscular strength, coordination, and endurance. Children with DS progress in their development, but at a lower rate than other children (Selikowitz, 1997c). Individuals with DS have a significant delay in the development of motor skills and balance, which is apparent during childhood and adulthood (W. Y. Wang & Ju, 2002).

Compared to the general population and other mentally handicapped individuals, individuals with DS rank lower in their performance in assessments of balance (Tsimaras & Fotiadou, 2004). Studies have shown that children as well as adults with DS can improve balance with physical activity training (Boswell, 1991; Carmeli, Kessel et al., 2002; Tsimaras & Fotiadou, 2004; W. Y. Wang & Chang, 1997; W. Y. Wang & Ju, 2002). Some of the characteristics that individuals with DS have that affect balance include hypotonia, strength deficits, and a small cerebellum and brain stem (Angelopoulou et al., 1999; Carmeli, Ayalon et al., 2002; Cioni et al., 1994; Connolly & Michael, 1986; Connolly et al., 1984; Cowie, 1970; Duger et al., 1999; Hayes & Batshaw, 1993; Jobling & Mon-Williams, 2000; Latash, 2000; Selikowitz, 1997b). Researchers have found that about 50 to 80% of individuals with DS have mild, moderate or severe hypotonia. Children with DS have less isokinetic strength in the arms and legs than non-intellectually disabled children (Cioni et al., 1994). In intellectually average children, muscular strength increases in a linear fashion until adolescence (Duger et al., 1999). Adolescents with DS fail to show an increase in muscular strength with age (Cioni et al., 1994). Some possible explanations for the lack of strength gains with age include premature aging of the neuromuscular junction (Cioni et al., 1994) or deficiency in quality and quantity of muscle tissue (Angelopoulou et al., 1999). Hormones do not seem to be the main cause of the lack of increase in muscular strength in children with DS (Cioni et al., 1994).

The cerebellum in children with DS develops at a slower rate when compared to children without intellectual disabilities (Connolly & Michael, 1986; Connolly et al., 1984; Cowie, 1970; Jobling & Mon-Williams, 2000; Latash, 2000). Children with DS might have difficulty maintaining balance due to delayed cerebellar maturation and a smaller cerebellum and brain stem (Connolly & Michael, 1986; Cowie, 1970).

Children with DS have greater body sway compared to their healthy counterparts (Vuillerme, 2001). Due to their greater sway at rest, these children have an unstable postural base (Vuillerme, 2001). The greater the amount of body sway, the poorer the postural control and balance (Kokubun et al., 1997).

Measuring Balance

It is very important to have guidelines and standards for assessing balance in individuals with mild motor impairments. Guidelines and standards allow physical educators, physical therapists and others to make appropriate decisions about interventions, program placement and planning, and goals based on results of an assessment (Duger et al., 1999; Tan et al., 2001).

There are many motor performance tests available for use. Motor function of infants ages 0 to 1 is assessed using the Bayley Scales of Infant Development – II (BSID-

II) (Connolly et al., 2006), Peabody Developmental Motor Scale II (PDMS)(H. H. Wang, Liao, & Hsieh, 2006), and Harris Infant Neuromotor test.(Harris & Daniels, 2001) Motor function of children is assessed using the Bruininks-Oseretsky test used in children ages 4½ to 14½ (Bruininks, 1978; Duger et al., 1999), Wood Motor Success screening tool used in children ages 4 to 9 (Zhang, Zhang, & Chen, 2004), PDMS used in children ages 0 to 5 (H. H. Wang et al., 2006), Movement Assessment Battery for Children ages 5 to 12 (Movement ABC) (Croce, Horvat, & McCarthy, 2001), and the Test of Gross Motor Development used in children ages 3 to 10 (Ulrich, 2000). Motor function of adults is assessed using the Fugl-Meyer test (Duger et al., 1999). All of these tests are valid and reliable for use with intellectually average individuals.

The Bruininks-Oseretsky test is widely used around the world and is considered the gold standard in testing motor proficiency (Duger et al., 1999; Hassan, 2001; J. Hattie & Edwards, 1987; Kambas & Aggeloussis, 2006). The Bruininks-Oseretsky test has been used to validate and determine the reliability of other tests including the Movement ABC (Croce et al., 2001) and the Wood motor success screening tool (Zhang et al., 2004). The Bruininks-Oseretsky test is widely used in other populations, however, its validity and reliability have not been tested (J. Hattie & Edwards, 1987). The Bruininks-Oseretsky test has been validated and found reliable in normal children age 4 ½ to 14 ½ (Duger et al., 1999). The reason this test has only been validated in this specific age group is due to lack of subjects over 15 years of age (Bruininks, 1978). Individuals with DS have difficulty performing the balance subsets of the Bruininks-Oseretsky test (Connolly et al., 1984). This test is useful as a measure of motor performance for intellectually handicapped individuals (Bruininks, 1978).

The validity of the Bruininks-Oseretsky test is based on its ability to evaluate motor development or proficiency (Bruininks, 1978). The following three areas were used as evidence to validate the Bruininks-Oseretsky test: 1) the relationship of the test content to significant aspects of motor development research studies, 2) relevant statistical properties of the test, and 3) the functioning of the test with contrasting groups of handicapped and normal children.

The balance portion of the Bruninks-Oseretsky test is consistent with previous research in motor development areas (Bruininks, 1978). Motor abilities develop with age and maturation. Therefore, test scores generally improve with age. The correlation median of the Bruininks-Oseretsky test is 0.78, indicating a close relationship between the subset scores of the test and the chronological age of the individual tested (Bruininks, 1978). The results of the Bruininks-Oseretsky test were compared between normal individuals to mildly retarded, moderately to severely retarded children, and children with learning disabilities. The results showed that the normal children performed significantly better than the mildly, moderately to severely retarded children, and children with learning disabilities (Bruininks, 1978).

The test-retest reliability (r = 0.56) for the balance subset of the Bruininks-Oseretsky test is the lowest of all the subsets in the test. The test-retest reliability coefficient for the entire test is 0.87 (Bruininks, 1978).

The subset of the Bruininks-Oseretsky test which assesses static and dynamic balance includes the following tests; standing on preferred leg on floor, standing on preferred leg on balance beam, standing on preferred leg on balance beam with eyes closed, walking forward on walking line, walking forward on balance beam, walking forward heel-to-toe on walking line, walking forward heel-to-toe on balance beam, and stepping over response speed stick on balance beam (Bruininks, 1978).

An additional 8 tests are included in the present study besides the 8 tests from the Bruininks-Oseretsky test. The additional 8 tests include the timed up-and-go test, full turn, forward reach, sit-to-stand, and standing on firm and soft surfaces with eyes open and closed.

The timed up-and go test is used to measure 4 different locomotor tasks (stand from chair, walk, turn around, sit on chair) (Carmeli et al., 2003; Mathias, Nayak, & Isaacs, 1986). The desired time to complete the task is from 22 to 26 seconds for a good level of independence in older adults (Carmeli et al., 2003). The advantage of using this test is that it is simple to conduct and little equipment is required. This test was found to be highly reliable in non-disabled older populations (Carmeli et al., 2003).

The forward reach test was found to be moderately reliable in an older population (Carmeli et al., 2003). The test measures the ability to shift the central body mass forward without taking a step (Carmeli et al., 2003; Duncan, Weiner, Chandler, & Studenski, 1990).

The full turn test validity and reliability was found to be high (Carmeli et al., 2003). This test measures the ability to complete a full turn in each direction with shoes off (K. Berg, Wood-Dauphinee, S., Williams, J., and Gayton, D., 1989; Carmeli et al., 2003).

The sit-to-stand test is used to measure the ability to transfer ones body weight from repeatedly standing and sitting for 20 seconds (Carmeli et al., 2003).

A number of studies have demonstrated that intellectually handicapped individuals score significantly lower than non-intellectually handicapped individuals in various motor tasks (Bruininks, 1978; Connolly & Michael, 1986; Connolly et al., 1984; Duger et al., 1999). However, it has not been demonstrated whether their lower performance is due to poor motor ability, lower intellectual performance or a combination of both (H. a. E. Hattie, H., 2001).

Many studies have tried to identify effective programs that might improve balance in individuals with Down syndrome; however, none of the studies have established reliability of the assessment methods to measure balance in these individuals (Boswell, 1991; Carmeli, Ayalon et al., 2002; Carmeli et al., 2003; Carmeli, Kessel et al., 2002; Le Blanc et al., 1977; W. Y. Wang & Ju, 2002). An assessment that incorrectly identifies balance (false positive) or fails to identify balance (false negative) misrepresents the individual's abilities and compromises correct interpretation. It is important to choose a reliable test that has little error associated with the scores.(Ulrich, 2000) The reliability of the tests to assess balance in individuals with Down syndrome must be established. It is equally as important to establish the reliability of other tests used in this population.

Chapter 3

Methods

Subjects

Twenty-one individuals with DS between the ages of 5 to 31 were invited to participate in this study. Participants were recruited from local elementary and secondary schools, group homes, and community in general. To be eligible for the study, participants must have been diagnosed with DS with mild or moderate mental retardation. Participants were able to walk independently and follow simple instructions. The participants cannot have any type of bony deformity in legs, physical disability, or uncorrected visual or auditory disability.

Overview of Research Design

Prior to data collection, approval of this study was obtained from the Institutional Review Board for the Use of Human Subjects for Research (IRB). Parents or guardians of each participant were fully informed of the procedures, risks, benefits and expectations, after which, parents or guardians who were willing to have their child(ren) participate in this study provided written informed consent. Parents or guardians completed a pre-participation questionnaire about their child(ren) (see Appendix A-1).

The age and gender of each participant were recorded. The height (cm) and mass (kg) of each participant were measured using a standard stadiometer. Body mass index (BMI; kg/m^2) was calculated using measured height and weight. To determine which was the preferred leg, we asked the participants to pretend to kick a ball. Each subject's preferred leg was recorded so the same leg would be tested each time.

A battery of sixteen balance tests were performed twice on each of two different days. Thus, each battery of test was performed a total of four times. The subject performed three trials of each test each time the test was performed. It took approximately half an hour to complete the battery of tests. Within each day, each battery of sixteen tests was separated by one hour. The two testing days were separated by 2 to 8 days. The order of the sixteen balance tests was randomized during each test period. Randomization of the testing sequence accounted for differences in performance related to factors such as learning, motivation, and attention span. Performing the battery of tests twice on each of two different days allowed the within and between day reliability to be determined. These tests have been previously used in other studies with individuals with DS and older DS patients.

Tests

The following tests were administered to each participant. This battery of tests included the balance assessments used by researchers to test balance in DS individuals. The subjects performed all sixteen tests with their shoes on; the same pair of shoes was used for all testing sessions. The overall center of gravity sway was measured in four static tests. These static tests were performed on the NeuroCom System. The center of gravity sway for each of the following static balance tests was measured: standing test with eyes opened and closed, standing on a soft surface with eyes opened and closed.

NeuroCom Tests:

Standing test-firm surface (NeuroCom Internacional, 2009) The participant stood on a firm surface with their feet parallel, with eyes open and their hands on their sides.

The participants were instructed to hold this position for ten seconds. The amount of time in seconds the participant could hold the position was recorded.

Standing test-firm surface with eyes closed (NeuroCom Internacional, 2009) The participant stood on a firm surface with their eyes closed and their hands on their sides. The participants were instructed to hold this position for ten seconds. The amount of time in seconds the participant could hold the position was recorded.

Standing test-soft surface (NeuroCom Internacional, 2009) The participant stood on a soft surface with eyes open and hands on their sides. The participant was instructed to hold this position for ten seconds. The amount of time in seconds the participant could hold the position was recorded.

Standing test-soft surface with eyes closed (NeuroCom Internacional, 2009) The subjects stood on a soft surface with eyes closed and hands on their sides for ten seconds. The participant was instructed to hold this position for ten seconds. The amount of time in seconds the participant could hold the position was recorded.

Other Tests:

Standing on preferred leg on the floor (Bruininks, 1978). The participant stood on their preferred leg looking at a target with their hands on their sides, and the other leg bent so that it was parallel to the floor. The participant was instructed to maintain this position for as long as they could. The amount of time in seconds the participant could hold the position was recorded. The maximum score was 10 seconds.

Standing on preferred leg on a balance beam (Bruininks, 1978).The participant stood on their preferred leg on a 4-inch by 12-foot balance beam, looking at a target with their hands on their sides, and the other leg bent so that it was parallel to the floor. The participant was instructed to maintain this position for as long as they could. The amount of time in seconds the participant could hold this position was recorded. The maximum score was 10 seconds.

Standing on preferred leg on a balance beam with eyes close (Bruininks, 1978). The participant stood on their preferred leg on the balance beam with their eyes closed, hands on their sides and the other leg bent so that it is parallel to the floor. The participant was instructed to maintain this position for as long as they could. The amount of time in seconds the participant could hold this position was recorded. The maximum score was 10 seconds.

Walking forward on a walking line (Bruininks, 1978). The participant walked forward on a walking line with a normal walking stride with hands on their sides. Taping a 5-meter length of 5 cm wide masking tape on the floor made the walking line. The participant was instructed to walk forward six steps to achieve maximum score. The number of consecutive steps completed on the walking line was recorded as a score for this test.

Walking forward on a balance beam (Bruininks, 1978). The participant walked forward on a balance beam with a normal walking stride. The participant was required to walk forward six steps to achieve maximum score. The number of consecutive steps completed on the balance beam was recorded as a score for this test.

Walking forward heel-to-toe on a walking line (Bruininks, 1978). The participant walked forward on the walking line, heel-to-toe with their hands on their sides. The participant was instructed to walk forward six steps to achieve maximum score. The number of consecutive steps completed on the walking line was recorded as a score for this test.

Walking forward heel-to-toe on a balance beam (Bruininks, 1978). The participant walked forward on the balance beam heel-to-toe with hands on their sides. The participant was instructed to walk forward six steps correctly to achieve maximum score. The number of consecutive steps completed on the balance beam was recorded as a score for this test.

Stepping over response speed stick on a balance beam (Bruininks, 1978). The participant walked forward on the balance beam, stepping over a response speed stick held in the middle of the beam by the examiner. The height of the response stick was below the knee of the participant. The participant walked with a normal stride with his/her hands on their sides. The score was recorded as pass or fail (1 or 0 points). A passing score was given if the participant stepped over the response stick without touching it and placed the next step on the balance beam. A failing grade was given if the participant touches the response stick or if they go around the stick.

Timed up and go test (Carmeli et al., 2003; Mathias et al., 1986). This test was used to measure a mixture of four different locomotor tasks. Participants began in the seated position. Participants stood, walked 9 m, turned around, returned to the chair, and sat down. Times were measured using a manual stopwatch. Time in seconds taken to complete the task were recorded.

Full turn (Carmeli et al., 2003). The 360º turn test measured the ability to perform a full turn. The number of steps taken and the amount of time in seconds to complete full turn in place was recorded. The test was performed twice, once in each direction. The success of the test depends on the integration between vestibular-proprioceptive and visual systems.

Forward reach (Carmeli et al., 2003; Duncan et al., 1990). The forward reach test measured margin of stability or the ability to shift center of mass by reaching forward as far as possible without taking a step. The individual was asked to stand up straight, make a fist holding a dry erase marker, and extend their right/left arm forward, was parallel to the white board. The white board was used to make the measurements. The participant was asked to reach as far as possible without taking a step, losing balance, or touching the white board. As they reached, they marked the white board with the dry erase pen. Functional reach was defined as the length between starting and ending positions.

Sit-to-stand test (Carmeli et al., 2003). The participant got up from an armless chair, stood, and then sat down again. The height of the chair depended on the individual’s height. Four chair heights were available for the test, 30, 35, 41, and 46 cm. The participant sat on the chair with their feet flat on the ground with their knees bent at a 90° angle. This was repeated for 20 seconds. The test measures the ability to transfer body weight upright and then down by use of knee extension muscles and back muscles. The number of sit-to-stands completed in 20 seconds were recorded.

Administering the Tests

The following equipment was used to perform the above-mentioned tests. Individual data sheets, informed consent, balance beam, masking tape, stopwatch, response speed stick, chair, foam mat, meter stick, and the NeuroCom.

The battery of tests took approximately 25 to 45 minutes to complete. The tests were completed in an area relatively free of noise, distractions and obstacles. The test was completed in a gymnasium or other room where enough space was available. The following general guidelines were followed while performing the tests on each subject:

1. The examiner established a positive and friendly environment with the subject. There was a brief introduction explaining what will take place. The subject was encouraged to do their best and there was continual verbal encouragement during testing.
2. Subject's individual data form (Appendix A 4) was completed.
3. Tests were administered.
4. Steady pace was kept during the test taking and the subject was not rushed to complete the tests.
5. Any errors the subject performed were corrected in a friendly manner.
6. Distractions around the subject were limited.

Statistical Analysis

Interclass correlation coefficient (ICC) was used to analyze the test-retest reliability of the raw scores and CG sway for all the tests between the four assessments. The best score per trial was used to test reliability. Generally ICC values less than 0.5 can be considered as indicating poor reliability, those between 0.5 and 0.75 as indicating moderate reliability, and those above 0.75 as indicating good reliability (Portney LG, 2000).

Means and standard deviations of scores for each test were calculated.

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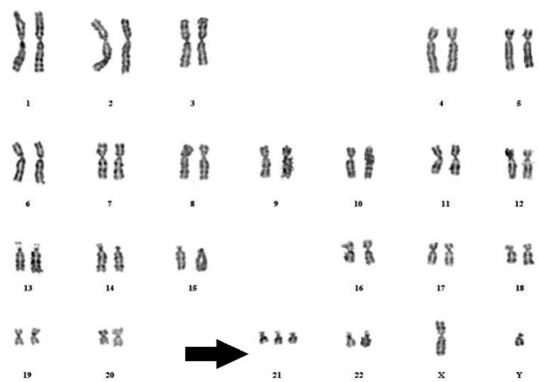

Figure 1. Trisomy 21 male karyotype

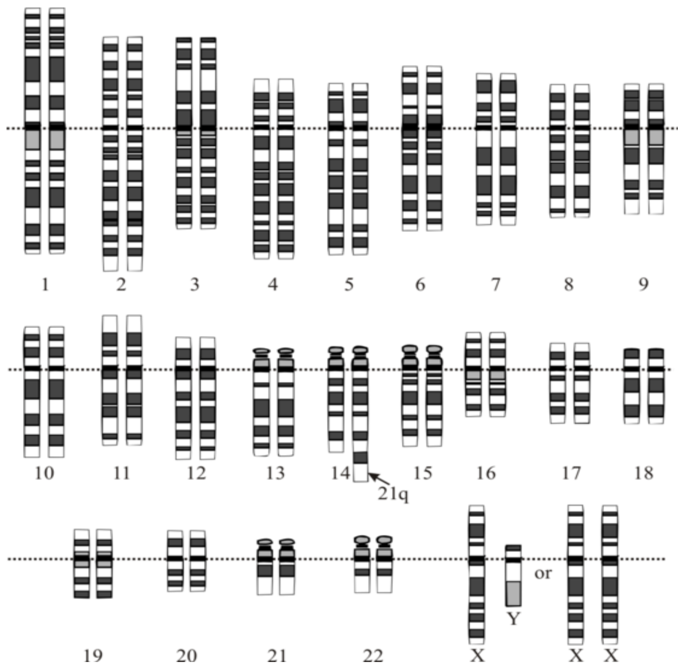

Figure 2. Translocation 14/21 in female (arrow shows composite chromosome consisting of part of chromosome 21)

Appendix A-1

Pre-Participation Questionnaire

____

Participant’s Name & ID:

____

Parent’s or Guardian’s Completing Questionnaire

	Yes	No	
1.	☐	☐	Does the subject have a bone or joint problem?
2.	☐	☐	Does the subject have a bony deformity?
3.	☐	☐	Does the subject have any physical disability?
4.	☐	☐	Does the subject have uncorrected visual or auditory disability?
5.	☐	☐	Can the subject walk independently?
6.	☐	☐	Can the subject follow simple instructions?

Comments:

Appendix A-2

Informed Consent Form

Consent to be a Research Subject

TITLE: Reliability of sixteen balance tests in individuals with Down syndrome.

INTRODUCTION. The purpose of this study is to determine the reliability of sixteen tests which assess balance. This study is being conducted by Romina Villamonte, a graduate student an the Department of Exercise Sciences at Brigham Young University. The primary faculty mentor for this research project is Pat Vehrs, PhD,. A faculty member in the Department of Exercise Sciences. You have been asked to provide informed consent for an individuals who has Down syndrome who is either your child or someone for whom you have legal guardianship. The person for whom you are providing consent to participate in this study has been asked to participate in this study because he/she is 5-35 years of age and has Down syndrome.

PROCEDURES. You will be asked to complete a Pre-Participation Questionnaire on behalf of the participant. The questionnaire asks questions about the participant that may exclude him/her from participating.

Your child will report to the Smith Field House (room 67) or the Triad Center in Salt Lake City (room 313) where his/her height and weight will be measured and he/she will complete 16 different physical tests that assess balance. The tests are the same tests that a physical therapist or doctor would use to assess balance. During the tests, your child will have to do things like walk a straight line on a piece of tape on the floor or a balance beam, walk heel-to-toe, and balance on one leg on the hard floor, or on a balance beam with their eyes open and closed. Some of the tests will be performed on a machine that measures balance. Each of the tests will be performed three times. Performing all 16 tests will take about an hour, but the actual amount of time may be less or more depending on how your child does.

Your child will be asked to return to the Smith Field House or the Triad Center and complete the same tests one hour later on the same day. Your child will also be asked to return to Smith Field House or the Triad Center and complete the tests (twice) on another day. The purpose of doing the tests four times (two ties on two different days) is to determine the reliability of the tests. The total amount of time it takes to complete all 16 tests twice on each day will be about 3 hours (including 1 hour break between tests). The total amount of time required to complete this study is about 6 hours (3 hours on two different days).

BENEFITS. As a benefit from participation in this study, you will receive a copy of the results from each tests completed by your child and the results will be explained to you. There are no other direct benefits to participating in this study. Nevertheless, by having your child participate in this study, we expect to gain a greater knowledge about the reliability of 16 tests and be able to recommend which tests or combination of tests would be best to use.

RISKS. There are minimal risks associated in participating in this study. Because the tests measure balance, there is a risk of falling. The balance beam that the participant will walk on is not raised off the floor so the risk of injury is minimal. The other tests are performed on the floor or on the balance machine. If by chance, an accident or injury were to occur, you will be consulted as to the appropriate medical response. If you are not available, the investigator will initiate an appropriate medical response, if necessary. You will be financially responsible for the cost of any medical care and treatment that is required. You may seek recovery of medical expenses from the participant's health insurance provider for the cost of any medical treatment.

CONFIDENTIALITY. All data gathered during this research will remain confidential. Group data may be published or presented in professional meetings. Individual personal information (name, height, weight, and personal test results) will remain confidential. Some pictures of your child performing the balance tests may be taken during this study. Pictures may be used in presentations or publications. Sufficient portions of the face will be obscured to hide the identity of the participant.

COMPENSATION. After the completion of each set of 16 tests, your child will receive $5 Cinemark Movie gift certificate that can be used at any Cinemark movie theatre. If your child completes all four sets of tests, he/she will receive a total of $20 in gift certificates. No other compensation will be provided.

PARTICIPATION. Your child has been invited to participate in this research and his/her participation is entirely voluntary. You or your child may discontinue his/her participation at any time without any penalty or loss of benefits to which he/she would otherwise be entitled. Choosing not to participate or choosing to stop participation will not affect your standing with Brigham Young University or any other organizations and affiliations that you have. The investigator may terminate the participant's participation due to inability to adhere to the research protocol, unwillingness to participate, or difficulty in scheduling appointments. The participant may also be excluded from this study if he/she has certain conditions, which will knowingly affect his/her performance on the 16 tests.

QUESTIONS ABOUT THE RESEARCH. If you have questions regarding this study, you may contact either Romina Villamonte at 801-422-9156, Romina@byu.net or Pat Vehrs, PhD at 801-422-1626, pat_vehrs@byu.edu.

QUESTIONS ABOUT YOUR RIGHTS AS A RESEARCH PARTICIPANT. If you have questions regarding your rights as a research participant, you may contact Christopher Dromey, PhD, IRB Chair by phone at 801-422-6461 or by mail at 133 TLRB, Brigham Young University, Provo, UT 84602, or by email at Christopher_Dromey@byu.edu.

I have been given opportunity to ask questions pertaining to the research and questions that I have asked have been answered to my satisfaction. I give consent for my child or person for whom I am a legal guardian to participate in this study.

____

Name of Participant

____

Name of Parent or Guardian

___________________________________ ____________________

Signature of Parent or Guardian Date

Appendix A-3

Child Participant Assent Form

CHILD PARTICIPANT ASSENT FORM

We want to tell you about a research study we are doing. A research study is a special way to find out about something. We are trying to find out more about which balance tests are the best for people with Down syndrome. You are being asked to join the study because you have Down syndrome.

If you decide that you want to be in this study, this is what will happen. You will need to come to BYU two different days. Each day, you will perform 16 tests that measure balance, then you will have a 1 hour break before you do the test again. The following time that you come to BYU, you will do the same things again. You will need to wear the same running shoes for all the tests.

Each session will last about 1 hour. Each visit will last about 3 to 4 hours in total.

Can anything bad happen to me?

We want to tell you about some things that might hurt or upset you if you are in this study. There is a risk of falling while doing the balance tests in the balance beam. A helper will be there to be sure you don't get hurt.

Can anything good happen to me?

We don't know if being in this research study will help you. But we hope to learn something that will help other people some day.

Do I have other choices?

You can choose not to be in this study.

Will anyone know I am in the study?

We won't tell anyone you took part in this study. When we are done with the study, we will write a report about what we found out. We won't use your name in the report.

What happens if I get hurt?

If you fall and become injured, someone will be there to help you and your parent/guardian will help you get better.

Will I get anything?

You will receive a $5 gift certificate (Cinemark Movie pass) for each session you complete. You can get a total of $20 when you complete all 4 sessions.

Before you say yes to be in this study; be sure to ask Romina to tell you more about anything that you don't understand.

What if I do not want to do this?

You don't have to be in this study. It's up to you. If you say yes now, but change your mind later, that's okay too. All you have to do is tell us.

If you want to be in this study, please sign or print your name.

☐ Yes, I will be in this research study ☐ No, I don't want to do this

Name of Child	Signature	Date
Parent/Guardian (if child is $\leq$ 7)	Signature	Date
Person obtaining assent	Signature	Date

Appendix A-4

Participant’s Data Form

Participant ID: ___________________________________

DOB: ______________________ Age: ___________________

Weight (kg): _________________ Height (m): _____________

Preferred Leg: ________________ BMI: __________________

TESTS:

Standing on preferred leg on floor

Trial 1	Trial 2	Trial 3

Standing on preferred leg on balance beam

Trial 1	Trial 2	Trial 3

Standing on preferred leg on balance beam with eyes closed

Trial 1	Trial 2	Trial 3

Walking forward on walking line

Trial 1	Trial 2	Trial 3

Walking forward on balance beam

Trial 1	Trial 2	Trial 3

Walking forward heel-to-toe on walking line

Trial 1	Trial 2	Trial 3

Walking forward heel-to-toe on balance beam

Trial 1	Trial 2	Trial 3

Stepping over response stick

Trial 1	Trial 2	Trial 3

Timed up-and-go test

Trial 1	Trial 2	Trial 3

Forward Reach

Trial 1	Trial 2	Trial 3

Sit-to-Stand test

Trial 1	Trial 2	Trial 3

Full Turn - Right

Trial 1	Trial 2	Trial 3
Time 1	Time 2	Time 3

Full Turn - Left

Trial 1	Trial 2	Trial 3
Time 1	Trial 2	Trial 3

Standing test on firm surface

Trial 1	Trial 2	Trial 3
Sway 1	Sway 2	Sway 3

Standing test on firm surface with eyes closed

Trial 1	Trial 2	Trial 3
Sway 1	Sway 2	Sway 3

Standing test on soft surface

Trial 1	Trial 2	Trial 3
Sway 1	Sway 2	Sway 3

Standing test on soft surface with eyes closed

Trial 1	Trial 2	Trial 3
Sway 1	Sway 2	Sway 3

Appendix B

Raw Data

ID	GENDER	WEIGTH	HEIGHT	BMI	AGE	PREF LEG	DAY	ATTEMPT
J1	0	42	1.42	20.8	12	RIGHT	1	1
J1	0	42	1.42	20.8	12	RIGHT	1	2
J1	0	42	1.42	20.8	12	RIGHT	2	1
J1	0	42	1.42	20.8	12	RIGHT	2	2
A2	0	63.2	1.54	26.6	24	RIGHT	1	1
A2	0	63.2	1.54	26.6	24	RIGHT	1	2
A2	0	63.2	1.54	26.6	24	RIGHT	2	1
A2	0	63.2	1.54	26.6	24	RIGHT	2	2
R3	1	77.6	1.65	28.5	25	RIGHT	1	1
R3	1	77.6	1.65	28.5	25	RIGHT	1	2
R3	1	77.6	1.65	28.5	25	RIGHT	2	1
R3	1	77.6	1.65	28.5	25	RIGHT	2	2
S4	0	21.8	1.12	17.4	8	LEFT	1	1
S4	0	21.8	1.12	17.4	8	LEFT	1	2
S4	0	21.8	1.12	17.4	8	LEFT	2	1
S4	0	21.8	1.12	17.4	8	LEFT	2	2
J5	0	42	1.44	20.3	22	RIGHT	1	1
J5	0	42	1.44	20.3	22	RIGHT	1	2
J5	0	42	1.44	20.3	22	RIGHT	2	1
J5	0	42	1.44	20.3	22	RIGHT	2	2
G6	1	15.9	0.99	16.2	5	LEFT	1	1
G6	1	15.9	0.99	16.2	5	LEFT	1	2
G6	1	15.9	0.99	16.2	5	LEFT	2	1
G6	1	15.9	0.99	16.2	5	LEFT	2	2
B7	1	17.7	0.99	18.1	5	LEFT	1	1
B7	1	17.7	0.99	18.1	5	LEFT	1	2
B7	1	17.7	0.99	18.1	5	LEFT	2	1
B7	1	17.7	0.99	18.1	5	LEFT	2	2
S8	0	47	1.47	21.8	14	LEFT	1	1
S8	0	47	1.47	21.8	14	LEFT	1	2
S8	0	47	1.47	21.8	14	LEFT	2	1
S8	0	47	1.47	21.8	14	LEFT	2	2
C9	1	15.9	0.94	18.0	5	RIGHT	1	1
C9	1	15.9	0.94	18.0	5	RIGHT	1	2
C9	1	15.9	0.94	18.0	5	RIGHT	2	1
C9	1	15.9	0.94	18.0	5	RIGHT	2	2
A10	0	111	1.47	51.4	29	LEFT	1	1
A10	0	111	1.47	51.4	29	LEFT	1	2
A10	0	111	1.47	51.4	29	LEFT	2	1
A10	0	111	1.47	51.4	29	LEFT	2	2
R11	1	81.7	1.65	30.0	31	RIGHT	1	1

ID	GENDER	WEIGTH	HEIGHT	BMI	AGE	PREF LEG	DAY	ATTEMPT
R11	1	81.7	1.65	30.0	31	RIGHT	1	2
R11	1	81.7	1.65	30.0	31	RIGHT	2	1
R11	1	81.7	1.65	30.0	31	RIGHT	2	2
K12	0	34	1.37	18.1	10	RIGHT	1	1
K12	0	34	1.37	18.1	10	RIGHT	1	2
K12	0	34	1.37	18.1	10	RIGHT	2	1
K12	0	34	1.37	18.1	10	RIGHT	2	2
M13	1	104.4	1.6	40.8	26	RIGHT	1	1
M13	1	104.4	1.6	40.8	26	RIGHT	1	2
D14	1	69.4	1.47	32.1	24	RIGHT	1	1
D14	1	69.4	1.47	32.1	24	RIGHT	1	2
D14	1	69.4	1.47	32.1	24	RIGHT	2	1
D14	1	69.4	1.47	32.1	24	RIGHT	2	2
S15	0	51.7	1.37	27.5	13	RIGHT	1	1
S15	0	51.7	1.37	27.5	13	RIGHT	1	2
S15	0	51.7	1.37	27.5	13	RIGHT	2	1
S15	0	51.7	1.37	27.5	13	RIGHT	2	2
M16	0	43.1	1.37	23.0	22	LEFT	1	1
M16	0	43.1	1.37	23.0	22	LEFT	1	2
M16	0	43.1	1.37	23.0	22	LEFT	2	1
M16	0	43.1	1.37	23.0	22	LEFT	2	2
T17	1	22.7	1.09	19.1	5	LEFT	1	1
T17	1	22.7	1.09	19.1	5	LEFT	1	2
T17	1	22.7	1.09	19.1	5	LEFT	2	1
T17	1	22.7	1.09	19.1	5	LEFT	2	2
S18	0	31.8	1.32	18.3	11	LEFT	1	1
S18	0	31.8	1.32	18.3	11	LEFT	1	2
S18	0	31.8	1.32	18.3	11	LEFT	2	1
S18	0	31.8	1.32	18.3	11	LEFT	2	2
D19	1	80.4	1.62	30.6	22	RIGHT	1	1
D19	1	80.4	1.62	30.6	22	RIGHT	1	2
D19	1	80.4	1.62	30.6	22	RIGHT	2	1
D19	1	80.4	1.62	30.6	22	RIGHT	2	2
E20	0	47	1.41	23.6	11	LEFT	1	1
E20	0	47	1.41	23.6	11	LEFT	1	2
E20	0	47	1.41	23.6	11	LEFT	2	1
E20	0	47	1.41	23.6	11	LEFT	2	2
B21	1	83.3	1.65	30.6	30	LEFT	1	1
B21	1	83.3	1.65	30.6	30	LEFT	1	2
B21	1	83.3	1.65	30.6	30	LEFT	2	1
B21	1	83.3	1.65	30.6	30	LEFT	2	2

ID	STNDFLR1	STNDFLR2	STNDFLR3	STNDBM1	STNDBM2	STNDBM3
J1	2	1	1	1	1	1
J1	1	1	2	1	1	1
J1	2	3	2	2	1	1
J1	2	3	1	2	2	2
A2	3	3	5	2	3	2
A2	5	2	2	4	3	7
A2	1	1	3	3.5	1	3
A2	4	2	4	4	4.7	3
R3	10	10	10	10	10	10
R3	10	10	10	10	10	10
R3	8	10	10	10	10	10
R3	10	10	10	10	10	10
S4	3	2	2	2	2	2
S4	5	2	4	1	2	2
S4	2	2	1	0	0	0
S4	2.7	2	1.6	0	0	0
J5	2	2	3	1	1	1
J5	2	2	1.5	1	1	1.5
J5	1.6	1.3	1	1	1	1
J5	1.5	1.7	1.5	1.4	0.8	0.9
G6	1	1	1	1.3	1.9	0
G6	1	1	1	0.6	0	0
G6	0.2	0.1	0.2	0.2	0	0
G6	0	0	0	0	0	0
B7	3	4	3	1	1	1
B7	3	3	2	1	1	2
B7	2	2	3	0	0	1
B7	1	3	2	1	1	2
S8	1	1	1	6	5	2.6
S8	3	5	4	5	4	3
S8	3	3	2	7.8	5.9	10
S8	9.5	10	6	4.5	9	10
C9	1	1	1.8	1.6	1.5	1
C9	1.3	1.5	1	1	1	1
C9	2	3	1	0.6	1.8	1.1
C9	0	0	0	0	0	0
A10	1.8	1.3	1	1.4	3	1.7
A10	2.6	2	2.9	2.7	8.5	2
A10	4	2.5	2	6.7	9.8	2
A10	2.5	3	2.6	1.4	1.6	1.5
R11	1.5	2	5	0.5	0	0.5

ID	STNDFLR1	STNDFLR2	STNDFLR3	STNDBM1	STNDBM2	STNDBM3
R11	1.4	1.2	2.1	2.5	1.9	1.8
R11	2.8	1	1	1.8	5	1.5
R11	1.4	1	2.6	1.8	2.1	3
K12	7	10	8	10	6	7
K12	4	3	6	9	3	3
K12	4	4	10	5	8	5
K12	6	5.6	5	2.9	3.5	2
M13	6.4	10	10	2	1	2
M13	6.1	2.8	4.4	1.2	1.1	8.3
D14	10	10	10	9.6	10	5.3
D14	10	10	10	10	10	10
D14	10	10	10	10	10	10
D14	10	10	10	10	10	10
S15	10	6	5	9	7	3
S15	6	8	10	10	5	10
S15	10	3.5	9	2.5	3.8	6
S15	10	5	4.3	7.2	5.2	5
M16	1.2	1	5	8.6	6.3	6.3
M16	2.6	1.5	1	1	2.4	3
M16	1.7	1.2	2.1	3.1	3.3	3
M16	1.7	2	1.6	1.1	1.8	2.1
T17	1.5	1.5	0.8	1	0.8	1.3
T17	1	1.4	1.3			
T17	0.6	1				
T17						
S18	1.1	1.2	1	0.7	1.1	0.7
S18	1	1	0.8	0.4	2.4	1.5
S18	3.6	1.2	1.2	1.4	3.9	2.5
S18	1.2	2	3.5	1.4	1.1	6
D19	2.7	5.9	4.3	3.2	5.4	3.6
D19	4.7	2.8	2.2	2.2	0.8	1.1
D19	3.9	2.5	3.6	3.8	3	1.4
D19	5.7	2.6	4	2.8	2	1.2
E20	1.1	4.2	1.7	1.1	0.8	2.1
E20	1.6	1.7	1.5	3.8	1.8	2.3
E20	1	2.4	2.9	3.5	2.8	1.7
E20	1	1.2	2.1	2.3	2.2	2.5
B21	1	2	2.3	2.6	1	2.5
B21	2.5	5	3.5	2	1.6	1.5
B21	2	2	4	2	2	2
B21	4	3	2.5	3	4.4	2.3

ID	STNDBMEC1	STNDBMEC2	STNDBMEC3	WKLN1	WKLN2	WKLN3
J1	0	0	0	5	4	6
J1	0	0	0	3	5	4
J1	0	0	0	6	4	3
J1	0	0	0	3	4	6
A2	0	0	0	6	6	6
A2	0	0	0	6	6	6
A2	1	2	3	6	6	6
A2	2	1	1	6	6	6
R3	6	5	4	6	6	6
R3	4	8	8	6	6	6
R3	10	5	7	6	6	6
R3	10	8.5	7	6	6	6
S4	0	0	0	6	6	3
S4	0	0	0	6	6	6
S4	0	0	0	6	3	6
S4	0	0	0	6	3	6
J5	0	0	0	4	4	6
J5	0	0	0	4	6	6
J5	0	0	0	6	4	5
J5	0	0	0	6	6	4
G6	0	0	0	0	0	0
G6	0	0	0	0	0	0
G6	0	0	0	0	0	0
G6	0	0	0	2	0	0
B7	0	0	0	6	5	0
B7	0	0	0	0	0	0
B7	0	0	0	5	4	5
B7	0	0	0	5	5	6
S8	0.6	0	0	4	6	6
S8	2	1	2	6	6	6
S8	1	2	1	5	5	6
S8	1	1	2.7	6	4	5
C9	0	0	0	4	3	3
C9	0	0	0	3	3	5
C9	0	0	0	5	4	6
C9	0	0	0	3	3	1
A10	0	0	0	6	6	6
A10	1	1.1	1.5	6	4	5
A10	0.7	0.7	1.5	6	6	4
A10	1	1.2	1.6	4	6	6
R11	0	0	0	5	5	1

ID	STNDBMEC1	STNDBMEC2	STNDBMEC3	WKLN1	WKLN2	WKLN3
R11	0.9	0.2	0	6	6	5
R11	0	0	0	3	6	5
R11	0.8	1.2	1.7	3	4	6
K12	1	1	0.5	6	6	6
K12	1	0.3	0.8	6	6	6
K12	0.8	0.8	1.4	6	6	6
K12	2.3	1.8	1	6	6	6
M13	0	0	0	5	6	6
M13	0	0	0	6	6	6
D14	0	0	0	6	6	6
D14	3	3	4	6	6	6
D14	6.8	3.2	3.3	6	6	6
D14	1.6	4.1	4.3	6	6	6
S15	7	3	2	6	6	6
S15	2	1	1	6	6	6
S15	0.8	1	1.1	6	6	6
S15	4	1	1.9	6	6	6
M16	2.7	0.8	0.8	6	6	6
M16	0.9	1.1	1.4	3	6	4
M16	0.7	1.2	1.1	6	5	6
M16	1.1	1	0.8	6	6	6
T17	0	0	0	6	2	4
T17	0	0	0	6	4	
T17				2	2	3
T17						
S18	0.9	0.7	0.9	4	5	6
S18	0.2	0.5	1	6	5	6
S18	0.8	0.9	1	6	6	4
S18	0.5	1	0.8	3	4	6
D19	2.5	1.1	1.5	5	6	6
D19	1	2	1.5	6	3	4
D19	0.4	1.1	0.5	4	6	5
D19	0.5	0.8	1.8	6	6	4
E20	0.7	0.4	0.7	6	4	6
E20	1.5	0.5	0.4	6	4	6
E20	0.5	1	1.1	5	3	5
E20	0.5	0.7	1	3	4	5
B21	1.1	0.4	0.6	6	6	6
B21	0.7	0.7	1.8	6	6	6
B21	1	1	1.5	6	6	5
B21	1	0.6	1.3	6	6	6

ID	WKBM1	WKBM2	WKBM3	WKHTTLN1	WKHTTLN2	WKHTTLN3
J1	4	4	4	2	2	2
J1	4	5	3	1	1	3
J1	3	2	3	1	2	1
J1	2	2	3	1	1	1
A2	6	5	6	4	3	2
A2	6	6	6	2	3	1
A2	3	4	6	1	0	0
A2	6	6	6	1	1	1
R3	6	6	6	6	6	6
R3	6	6	6	6	6	6
R3	6	6	6	6	6	6
R3	6	6	6	6	6	6
S4	6	6	6	4	5	5
S4	4	6	6	4	4	6
S4	6	6	6	4	3	3
S4	6	6	6	2	2	0
J5	3	4	3	0	0	1
J5	4	2	4	0	1	0
J5	2	3	4	0	0	1
J5	3	4	3	0	0	0
G6	2	3	3	0	0	0
G6	2	3	1	0	0	0
G6	0	2	0	0	0	0
G6	0	0	0	0	0	0
B7	5	3	6	0	0	0
B7	4	4	6	0	0	0
B7	5	4	5	0	0	0
B7	6	6	6	0	0	0
S8	6	6	6	2	1	2
S8	5	5	6	2	1	1
S8	4	6	5	2	1	1
S8	5	6	6	2	1	1
C9	4	3	4	0	0	0
C9	4	3	6	0	0	0
C9	3	5	5	0	0	0
C9	3	4	3	0	0	0
A10	3	1	3	2	5	2
A10	1	3	6	4	2	1
A10	3	2	4	3	4	5
A10	2	4	3	2	2	3
R11	2	2	2	0	0	0

ID	WKBM1	WKBM2	WKBM3	WKHTTLN1	WKHTTLN2	WKHTTLN3
R11	2	2	2	0	2	1
R11	2	6	3	1	0	2
R11	4	5	3	4	3	2
K12	6	6	6	6	2	1
K12	6	6	6	2	2	3
K12	6	6	6	1	2	2
K12	6	6	6	6	4	5
M13	2	3	6	2	5	4
M13	2	1	5	6	4	4
D14	6	6	6	6	6	6
D14	6	6	6	6	6	6
D14	6	6	6	6	6	6
D14	6	6	6	6	6	6
S15	6	6	6	5	5	5
S15	6	6	6	3	3	5
S15	6	6	6	2	3	4
S15	5	4	6	6	5	6
M16	6	6	6	0	0	1
M16	6	6	6	0	0	0
M16	6	6	6	2	6	3
M16	6	6	6	6	3	2
T17	5	2	3	1	0	0
T17	4	3	3	0	0	0
T17	3	2	2			
T17						
S18	3	4	3	2	2	3
S18	3	4	2	0	1	0
S18	3	6	6	0	0	0
S18	3	4	6	0	1	2
D19	4	4	3	3	2	3
D19	5	4	5	2	2	3
D19	2	2	2	2	1	5
D19	3	3	3	1	1	1
E20	6	2	4	0	0	0
E20	5	5	4	1	0	1
E20	6	6	4	3	1	1
E20	2	4	2	6	1	1
B21	6	2	4	2	2	3
B21	3	3	4	2	1	5
B21	6	5	4	4	3	4
B21	6	3	3	4	4	2

ID	WKHTTBM1	WKHTTBM2	WKHTTBM3	STICK1	STICK2	STICK3
J1	1	1	1	0	1	0
J1	1	2	1	0	0	1
J1	1	1	0	0	0	1
J1	1	1	0	1	0	1
A2	2	3	2	0	1	0
A2	2	1	0	1	1	1
A2	1	0	0	1	0	0
A2	1	1	1	0	0	0
R3	6	6	6	1	1	1
R3	6	6	6	1	1	1
R3	6	6	6	1	1	1
R3	6	6	6	1	1	1
S4	5	5	5	1	1	0
S4	3	6	6	0	1	0
S4	1	1	0	0	1	0
S4	1	0	0	0	0	1
J5	0	0	0	0	0	1
J5	0	0	0	0	1	0
J5	0	0	0	0	0	0
J5	0	0	0	0	0	0
G6	0	0	0	0	0	0
G6	0	0	0	0	0	0
G6	0	0	0	0	1	0
G6	0	0	0	0	0	0
B7	1	1	0	0	1	0
B7	0	1	0	0	0	1
B7	0	0	0	0	0	1
B7	0	0	0	0	1	1
S8	2	2	3	1	0	1
S8	1	5	3	1	1	1
S8	2	3	2	1	1	1
S8	1	2	2	1	1	0
C9	1	0	0	0	0	0
C9	0	0	0	0	1	0
C9	0	0	0	0	0	0
C9	0	0	0	0	0	0
A10	1	1	1	0	0	0
A10	1	2	1	0	0	1
A10	2	1	2	0	0	1
A10	1	2	2	1	0	0
R11	0	0	0	0	0	1

ID	WKHTTBM1	WKHTTBM2	WKHTTBM3	STICK1	STICK2	STICK3
R11	1	1	0	1	0	1
R11	0	1	2	0	0	1
R11	2	1	0	0	1	0
K12	4	2	1	0	1	1
K12	3	1	0	0	1	0
K12	1	1	2	1	0	0
K12	2	1	3	0	1	1
M13	2	1	0	1	0	0
M13	5	2	0	1	1	1
D14	6	6	6	1	1	1
D14	6	6	6	0	0	1
D14	6	6	6	0	1	1
D14	6	6	6	1	1	1
S15	3	3	3	0	0	1
S15	4	5	4	0	1	1
S15	4	6	6	0	1	1
S15	6	6	6	0	1	0
M16	1	0	0	0	1	1
M16	0	0	0	1	0	0
M16	2	3	2	1	0	1
M16	2	3	4	0	0	1
T17	0	0	0	0	1	0
T17	0	0	0	0	0	0
T17						
T17						
S18	2	2	3	0	1	1
S18	2	1	2	0	1	0
S18	1	1	0	1	1	1
S18	0	1	0	1	0	1
D19	2	2	1	0	1	1
D19	1	2	3	0	1	0
D19	1	3	2	0	1	0
D19	2	3	1	0	0	0
E20	1	1	1	0	1	0
E20	1	1	0	0	0	0
E20	2	2	1	0	0	1
E20	3	2	0	0	0	1
B21	1	1	1	1	0	0
B21	3	1	0	0	0	0
B21	2	1	2	0	1	0
B21	3	1	2	1	0	0

ID	TIME1	TIME2	TIME3	REACH1	REACH2	REACH3	RTRNTM1
J1	25	21	20	14	0	7	
J1	16	16	17	7	6	7.5	
J1	20	19	22	13	15	20	
J1	18	24	25	18	14	20	
A2	23	22	22	7.5	8.5	7	
A2	20	19	21	6	6	5	
A2	16	16	19	10.5	7	10	3.7
A2	17	16	16	7	9	9	3.6
R3	22	23	24	21	21	20	
R3	20	20	22	17	17	21	2.3
R3	22	21.5	21.1	21	16	20	2
R3	20.6	21.4	22.5	21.5	24	21.5	2
S4	17	21	20	0	7	7.5	
S4	36	27	26	10	9	11	
S4	41	31	25	9	11	11.5	2.9
S4	30	33	39	6	8	9	2.5
J5	22	20	20	26	28	21	1.7
J5	18	19	19	18	21	21	2.2
J5	20.8	23.2	21.9	23	23	24	2.9
J5	24.7	25	22.4	25	23	26	2
G6	35	17	13	0	0	0	1.1
G6	24	24	37	0	0	0	1.8
G6				0	0	0	3.5
G6				0	0	0	3.9
B7	20.6	21	19	7	15	0	2.5
B7	19	20	22	18	21	0	2.3
B7	20	21	21	12	21	12	1.7
B7	21	20	20	7	9	24	1
S8	19.6	18.6	15.1	23	24	25	2
S8	16.2	15.9	16.7	29	29	38	2.6
S8	14	16	16	19	22	23	2
S8	17	14	13	19.5	23	23	1.5
C9	24	21	21.4	8	15	11	1.7
C9	32	30	23.5	13	10	8	1.6
C9	57	22	20	18	0	0	2
C9	22	27.6	27.6	0	0	0	2.1
A10	25	25.5	23.8	22.5	23.5	24	2.2
A10	23.8	23.1	21	27	24	27	2.1
A10	17.8	17.2	21.1	27	25.5	26	1.9
A10	20.7	20.6	21	26	27	27	2.4
R11	16.3	16.5	15.6	20	19.5	12	2.5

ID	TIME1	TIME2	TIME3	REACH1	REACH2	REACH3	RTRNTM1
R11	15.4	14.3	14.9	18.5	17.5	19	3.4
R11	14	14.8	14.7	23	21	21	1.4
R11	14.2	18	17.1	20	22	19	2.6
K12	17	17.8	15.1	19	19	20	3.3
K12	17.7	17.6	15.7	18	19	20	1.6
K12	14.4	15.6	13	22	25	29	1.6
K12	14.1	15.6	14.9	19	20	24	2.7
M13	19.6	20.9	20.8	12	11.5	10	3
M13	22.1	20.5	19.1	15	17	19	3
D14	14	11.7	12.9	19	19	19	3.4
D14	19.3	21	20.2	16.5	19	21	1.2
D14	19.1	19.1	20.7	17	11	14	1.4
D14	19.5	21.5	24	19	15	18	2
S15	29	25	24	11	14	13	5
S15	21	21	17	15	14	14.5	3.6
S15	24.5	25	22.9	18	24	27	2.6
S15	25	19	20	23	20	20	4
M16	33.2	35.8	18.2	8	6	7	1.9
M16	18.5	21.2	24.6	21	23	21	2.5
M16	26	20.8	21	16	20	18	2.7
M16	22.5	23.1	24.9	18	25	38	2.8
T17	16.4	18.5	18.7				
T17							1.4
T17	23.9	14	16				4
T17	35	18	13				
S18	21.5	24.8	18.2	15	18	17	1.3
S18	30	19.1	20	20	21	17	1.4
S18	21	14.2	17.9	16	22	14	2.3
S18	17.8	14	15	19	15	23	2
D19	23.8	25.2	23	14	15.5	17.5	2.6
D19	18.4	17.3	19.3	17	18	16.5	2.4
D19	29.1	20.1	19.5	17	19.5	21	3.9
D19	20.8	19.4	17	15	16	15.5	2.9
E20	30	24.4	23.6	8			2
E20	22	29	18.4	7	6	12	1.6
E20	23.4	18.5	18.4	17	17	19	2
E20	20.3	19.6	23.6	17	23	16	3.5
B21	28	26	19.1	29	16	24	1.1
B21	24.5	23.1	20.2	24	27	43	1.9
B21	26	28	25	26	31	30	2.7
B21	24.7	27.4	27.9	32	44	44	2.7

ID	RTRNTM2	RTRNTM3	RTRNSTP1	RTRNSTP2	RTRNSTP3
J1			5	5	6
J1			5	4	4
J1			4	5	5
J1			5	6	5
A2			6	6	5
A2			6	5	6
A2	3.1	2.6	5	5	5
A2	2.8	3.5	6	5	5
R3			4	4	4
R3	2.1	2.3	4	4	4
R3	2.4	2.3	4	5	4
R3	3	2.7	4	4	4
S4			5	5	
S4			6	7	5
S4	2.9	4	6	6	8
S4	1.9	1.4	4	3	3
J5	2	2.7	4	5	5
J5	2.1	1.9	5	5	5
J5	2.5	2.9	5	6	6
J5	2.7	3.4	5	6	6
G6	2.2	2	4	4	4
G6	2	2	4	4	4
G6	3.4		4	5	
G6	3.6	3.7	3	3	4
B7	2.7	2.5	5	5	5
B7	2.5	2.5	5	5	5
B7	2	2	5	5	5
B7	7.1.5	1.7	3	3	3
S8	2.7	2	4	5	5
S8	2.6	2.2	5	5	5
S8	1.4	1.7	3	3	4
S8	1.4	1.4	4	4	4
C9	2	1.7	4	4	4
C9	1.4	1.4	4	4	4
C9	1.7	2	5	4	5
C9	2	2	5	6	5
A10	2.3	2.5	5	6	6
A10	2	2.3	5	4	4
A10	2.2	2.7	5	5	4
A10	2.1	2.4	5	4	4
R11	2.8	2.9	6	6	5

ID	RTRNTM2	RTRNTM3	RTRNSTP1	RTRNSTP2	RTRNSTP3
R11	3.3	2.3	4	4	4
R11	2.8	2.2	5	5	5
R11	2.7	2.7	5	6	5
K12	2	1.9	4	5	4
K12	1.4	1.3	3	3	4
K12	2	2.1	4	4	4
K12	4	2.8	4	7	5
M13	6	3	4	5	4
M13	3.6	4.1	4	5	5
D14	2.7	2	5	5	4
D14	1.3	2	3	3	4
D14	2.6	3.3	5	5	7
D14	2.7	3	5	5	5
S15	2.7	2.9	5	5	5
S15	3.5	5	5	4	5
S15	3.9	4.6	4	5	5
S15	3	2	6	5	4
M16	1.9	4	5	5	6
M16	2.5	3.8	4	5	5
M16	2.2	3.2	4	4	4
M16	2.4	2.6	4	4	5
T17					
T17			5		
T17	1		4	3	
T17					
S18	1.5	1.7	5	4	4
S18	1.2	1	3	4	4
S18	1.3	1	5	4	4
S18	1.5	1.1	4	4	4
D19	3.5	3.7	6	6	6
D19	3.1	2.6	6	5	5
D19	4.1	4.1	7	7	6
D19	2.9	2.3	5	6	5
E20	4.6	2	4	6	4
E20	1.7	2.1	5	4	4
E20	2.8	2.7	5	6	5
E20	3.3	2.5	5	5	6
B21	1.4	1.1	3	3	3
B21	2.6	2.2	4	3	3
B21	1.7	2	5	4	4
B21	2.2	2.3	5	4	3

ID	LTRNTM1	LTRNTM2	LTRNTM3	LTRNSTP1	LTRNSTP2
J1				6	6
J1				5	5
J1				5	6
J1				6	5
A2				6	5
A2				6	6
A2	3.4	3.3	3.5	5	5
A2	3	3.1	3.1	5	5
R3				4	4
R3	2.4	2.4	2.3	4	4
R3	1.9	2.1	2	4	4
R3	2.7	2.5	2.2	5	4
S4				4	5
S4				6	5
S4	3	3.7	2.9	4	5
S4	4.2	2.6	3.6	5	5
J5	2	2.5	2.8	4	6
J5	2.2	2	2.8	5	6
J5	2.5	2.3	2.9	5	5
J5	2.5	2.6	2.7	6	5
G6					
G6					
G6	2.4	3.2	3.6	3	3
G6	3.1	3.3	3.2	3	3
B7	2.1	2	2	5	4
B7					
B7	2	1.5	2	5	5
B7	1.5	1.5	1.7	3	4
S8	1.8	2.6	1.9	3	5
S8	1.8	2.2	1.7	5	4
S8	1.1	2.1	1.2	3	4
S8	1.4	1.3	1.4	4	4
C9	2.4	2.5	2.5	5	5
C9	2.4	2.4	2	6	6
C9	1.2	1.3	1.1	3	3
C9	1.1	1.2	1.1	3	3
A10	3.1	2.6	3	5	5
A10	1.9	2	2.1	4	4
A10	2	2.2	2.4	5	5
A10	1.9	2	2.2	4	4
R11	2.9	2.6	2.3	5	5

ID	LTRNTM1	LTRNTM2	LTRNTM3	LTRNSTP1	LTRNSTP2
R11	2.3	2.2	2.3	5	4
R11	2.7	2.4	3.1	5	5
R11	2.2	2.6	2.3	6	5
K12	2.5	2	2.2	4	4
K12	2.2	1.2	1.2	3	2
K12	1.9	2.1	2.6	5	4
K12	2	2.1	2	4	4
M13	5.3	4.2	6.4	5	6
M13	3.8	3.6	3.9	4	3
D14	1.7	1.6	1.5	3	3
D14	2	2.1	1.8	5	4
D14	2.3	4.2	2	5	5
D14	2.5	2.3	3	5	5
S15	4.4	2.6	2.4	5	6
S15	3.4	7.4	3.5	4	4
S15	5.5	4	5.1	7	5
S15	3	3	4	5	4
M16	3	2.6	3.9	5	5
M16	1.6	2	1.9	4	4
M16	2.3	2.7	2.8	5	4
M16	2	2.1	3.2	5	4
T17	1.6	2.3	3.1	4	5
T17	1.8	1.3	1.4	5	4
T17					
T17					
S18	2.9	3.6	1.4	7	7
S18	1.5	1.5	1.5	3	4
S18	1.4	1.3	1.3	4	4
S18	1.5	2	1.6	4	5
D19	3.3	3.4	4	6	5
D19	2.8	2.7	3.2	5	5
D19	5.3	5	4.5	5	6
D19	2.7	3.1	3	5	6
E20	2.1	2.1	2.6	4	4
E20	2.1	2.5	2.8	4	4
E20	2.8	3.8	2.4	5	5
E20	3.7	3.4	3	6	6
B21	2	1.3	1.7	4	3
B21	1.8	2.1	2	4	3
B21	1.5	1.5	1.3	4	4
B21	2.4	1.9	2.2	4	4

ID	LTRNSTP3	STSTND1	STSTND2	STSTND3	STNDFRM1	STNDFRM2
J1	4	10	9	9	10	10
J1	5	10	9	8	10	10
J1	5	6	7	7	10	10
J1	5	9	6	8	10	10
A2	6	8	9	10	10	10
A2	5	8	9	8	10	10
A2	5	9	11	11	10	10
A2	6	9	11	10	10	10
R3	4	7	7	7	10	10
R3	4	7	6	7	10	10
R3	4	7	7	7	10	10
R3	5	7	7	7	10	10
S4					10	10
S4	4				10	10
S4	5	7	7	7	10	10
S4	6	4	8	5	10	10
J5	6	7	6	6	10	10
J5	6	7	6	7	10	10
J5	6	8	7	7	10	10
J5	6	7	8	8	10	10
G6		6	4	7	0	10
G6		6	6	2	10	10
G6	4	6	5	6		
G6	4	6	6			
B7	5	5	9	3	10	10
B7		7			10	10
B7	5	7	5		0	10
B7	3	7	9	9	10	0
S8	4	6	8	9	10	10
S8	4	9	9	11	10	10
S8	3	8	8	8	10	10
S8	3	9	7	9	10	10
C9	5	7	7	5	10	10
C9	5	7	7	5	10	0
C9	3	9	7	7	10	10
C9	3	5	8	7	2	10
A10	5	6	6	6	10	10
A10	5	7	6	6	10	10
A10	5	5	6	6	10	10
A10	4	5	5	5	10	10
R11	5	9	8	10	10	10

ID	LTRNSTP3	STSTND1	STSTND2	STSTND3	STNDFRM1	STNDFRM2
R11	5	8	8	8	10	10
R11	5	9	8	8	10	10
R11	6	10	8	9	10	10
K12	4	7	7	6	10	10
K12	2	6	5	10	10	10
K12	5	7	7	7	10	10
K12	4	8	7	9	10	10
M13	4	4	4	6	10	10
M13	4	4	7	6	10	10
D14	3	5	7	7	10	10
D14	3	8	9	8	10	10
D14	6	9	8	8	10	10
D14	5	7	8	8	10	10
S15	5	5	5	6	10	10
S15	5	6	6	5	10	10
S15	6	4	5	5	10	10
S15	6	5	6	6	10	10
M16	6	7	6	9	10	10
M16	4	5	9	5	10	10
M16	5	7	5	6	10	10
M16	5	8	6	5	10	10
T17	5	10	7	5	10	10
T17	4				10	
T17		1	3		10	
T17					10	7
S18	4	7	6	6	10	10
S18	4	7	4	3	10	10
S18	4	4	5	2	10	10
S18	4	3	7		10	10
D19	6	8	9	9	10	10
D19	5	8	7	7	10	10
D19	6	8	6	8	10	10
D19	5	7	8	8	10	10
E20	5	5	5	5	10	10
E20	4	9	7	8	10	10
E20	5	6	7	5	10	10
E20	6	7	6	9	10	10
B21	3	8	4	6	10	10
B21	4	7	6	4	10	10
B21	4	6	5	4	10	10
B21	4	4	5	6	10	10

ID	STNDFRM3	STNDFRMEC1	STNDFRMEC2	STNDFRMEC3
J1	10	10	10	10
J1	10	10	10	10
J1	10	10	10	10
J1	10	10	10	10
A2	10	10	10	10
A2	10	10	10	10
A2	10	10	10	10
A2	10	10	10	10
R3	10	10	10	10
R3	10	10	10	10
R3	10	10	10	10
R3	10	10	10	10
S4	10	10	10	10
S4	10	0	0	0
S4	10	10	10	10
S4	10	10	10	10
J5	10	10	10	10
J5	10	10	10	10
J5	10	10	10	10
J5	10	10	10	10
G6	0	3.5	3.5	0
G6	0	10	10	10
G6				
G6				
B7	0	10	10	10
B7	10	10	10	10
B7	10	10	10	10
B7	10	10	10	9
S8	10	10	10	10
S8	10	10	10	10
S8	10	10	10	10
S8	10	10	10	10
C9	10	0	0	0
C9	0	5	0	0
C9	10	10	10	10
C9	10	10	10	10
A10	10	10	10	10
A10	10	10	10	10
A10	10	10	10	10
A10	10	10	10	10
R11	10	10	10	10

ID	STNDFRM3	STNDFRMEC1	STNDFRMEC2	STNDFRMEC3
R11	10	10	10	10
R11	10	10	10	10
R11	10	10	10	10
K12	10	10	10	10
K12	10	10	10	10
K12	10	10	10	10
K12	10	10	10	10
M13	10	10	10	10
M13	10	10	10	10
D14	10	10	10	10
D14	10	10	10	10
D14	10	10	10	10
D14	10	10	10	10
S15	10	10	10	10
S15	10	10	10	10
S15	10	10	10	10
S15	10	10	10	10
M16	10	10	10	10
M16	10	10	10	10
M16	10	10	10	10
M16	10	7	5	10
T17		5	7	5
T17	10	10	5	5
T17	10			
T17				
S18	10	10	10	10
S18	10	10	10	10
S18	10	10	10	10
S18	10	10	10	10
D19	10	10	10	10
D19	10	10	10	10
D19	10	10	10	10
D19	10	10	10	10
E20	10	10	10	10
E20	10	10	10	10
E20	10	10	10	10
E20	10	10	10	10
B21	10	10	10	10
B21	10	10	10	10
B21	10	10	10	10
B21	10	10	10	10

ID	STNDFM1	STNDFM2	STNDFM3	STNDFMEC1	STNDFMEC2
J1	10	10	10	10	10
J1	10	10	10	10	10
J1	10	10	10	10	10
J1	10	10	10	10	10
A2	10	10	10	10	10
A2	10	10	10	10	10
A2	10	10	10	10	10
A2	10	10	10	10	10
R3	10	10	10	10	10
R3	10	10	10	10	10
R3	10	10	10	10	10
R3	10	10	10	10	10
S4	10	10	10	10	10
S4	10	10	10	10	10
S4	10	10	10	10	10
S4	10	10	10	10	10
J5	10	10	10	0	10
J5	10	10	10	10	10
J5	10	10	10	10	0
J5	10	10	10	10	10
G6	10	10	0	2	2
G6	10	10	0	10	10
G6					
G6					
B7	10	10	0	10	10
B7	10	10	10	10	10
B7	10	10	10	10	10
B7	10	10	10	10	10
S8	10	10	10	10	10
S8	10	10	10	10	10
S8	10	10	10	10	10
S8	10	10	10	10	10
C9	10	10	10	10	0
C9	10	10	10	10	10
C9	10	10	10	10	10
C9	10	10	10	10	10
A10	10	10	10	10	10
A10	10	10	10	10	10
A10	10	10	10	10	10
A10	10	10	10	10	10
R11	10	10	10	10	10

ID	STNDFM1	STNDFM2	STNDFM3	STNDFMEC1	STNDFMEC2
R11	10	10	10	10	10
R11	10	10	10	10	10
R11	10	10	10	10	10
K12	10	10	10	10	10
K12	10	10	10	10	10
K12	10	10	10	10	10
K12	10	10	10	10	10
M13	10	10	10	10	0
M13	10	10	10	10	10
D14	10	10	10	10	10
D14	10	10	10	10	10
D14	10	10	10	10	10
D14	10	10	10	10	10
S15	10	10	10	10	10
S15	10	10	10	10	10
S15	10	10	10	10	10
S15	10	10	10	10	10
M16	10	10	10	10	10
M16	10	10	10	10	10
M16	10	10	10	10	10
M16	10	10	10	10	10
T17			10		
T17	10	10	10		
T17	10	10	10	5	
T17	10				
S18	10	10	10	10	10
S18	10	10	10	10	10
S18	10	10	10	10	10
S18	10	10	10	10	10
D19	10	10	10	10	10
D19	10	10	10	10	10
D19	10	10	10	10	10
D19	10	10	10	10	10
E20	10	10	10	10	10
E20	10	10	10	10	10
E20	10	10	10	10	10
E20	10	10	10	10	10
B21	10	10	10	10	10
B21	10	10	10	10	10
B21	10	10	10	10	10
B21	10	10	10	10	10

ID	STNDFMEC3	SFSWY1	SFSWY2	SFSWY3	SFECSWY1	SFECSWY2
J1	10					
J1	10					
J1	10					
J1	10					
A2	10					
A2	10					
A2	10					
A2	10					
R3	10					
R3	10					
R3	10	0.6	0.6	0.8	0.4	0.3
R3	10	0.4	0.3	0.4	0.2	0.4
S4	10					
S4	10					
S4	10	0.7	1.2	1.6	1.3	1.5
S4	10	1.1	1.9	1.6	1.3	0.6
J5	0	0.4	0.4	0.3	0.6	0.5
J5	10	0.6	0.6	0.5	0.3	0.6
J5	0	0.4	0.8	0.3	0.6	0.2
J5	0	0.6	0.6	0.5	0.3	0.5
G6	0		3.3		4.4	5.9
G6	0	2.2	3.2		2.7	3.8
G6						
G6						
B7	10	1.4	0.8		0.9	1.3
B7	0	1.8	2.5	2.7	2.5	5
B7	10		1.4	2.3	2	2
B7	10	0.6		1	2.4	1.5
S8	10	0.5	0.4	0.5	0.7	0.7
S8	10	0.5	0.6	0.4	0.7	0.6
S8	10	0.3	0.6	1.3	0.7	0.6
S8	10	0.4	0.6	0.5	0.7	0.7
C9	0	2.2	2.2	1.9		
C9	10	3			5.9	
C9	10	2.5	2.6	4.1	5.9	3.3
C9	10	5.9	5.8	5.9	5.9	3.1
A10	10	0.2	0.3	0.3	0.4	0.4
A10	10	0.4	0.2	0.2	0.4	0.6
A10	10	0.4	0.5	0.4	0.4	0.3
A10	10	0.4	0.3	0.3	0.4	0.5
R11	10	0.2	0.2	0.1	0.2	0.4

ID	STNDFMEC3	SFSWY1	SFSWY2	SFSWY3	SFECSWY1	SFECSWY2
R11	10	0.5	0.4	0.4	0.5	0.4
R11	10	0.6	0.5	0.8	0.3	0.2
R11	10	0.3	0.2	0.7	0.4	0.3
K12	10	0.9	0.1	0.6	0.6	0.6
K12	10	0.8	0.7	0.9	0.8	1.3
K12	10	0.9	0.8	1	0.8	1
K12	10	1	1.6	1.7	1	1
M13	0	0.5	0.4	0.3	0.5	0.7
M13	10	0.4	0.4	0.4	0.7	0.6
D14	10	0.5	0.5	0.5	1	0.7
D14	10	0.7	0.7	0.6	0.8	0.9
D14	10	0.5	0.9	0.5	0.5	0.5
D14	10	0.4	0.7	0.5	0.8	0.6
S15	10	0.3	0.4	0.6	0.7	0.6
S15	10	0.7	1	0.8	1	0.8
S15	10	0.6	0.6	0.4	0.6	0.9
S15	10	0.7	1.2	0.9	1	0.8
M16	10	1	0.9	1.2	0.6	1.1
M16	10	1.4	1.8	1.7	1	1.3
M16	10	1.4	0.8	1.2	0.5	0.9
M16	7	0.8	1.8	1.2	0.7	1.6
T17		2.9	4.4		2	4.6
T17	5	2.5		3.6	4.5	2.8
T17		5.5		5.9		
T17		2.6	5.9			
S18	10					
S18	10					
S18	10					
S18	10					
D19	10					
D19	10					
D19	10					
D19	10					
E20	10					
E20	10					
E20	10					
E20	10					
B21	10	0.4	0.3	0.3	1.2	0.6
B21	10	0.4	0.5	1.1	0.7	0.4
B21	10	0.5	0.4	0.4	0.4	0.6
B21	10	0.7	0.4	0.8	0.7	0.3

ID	SFECSWY3	SFMSWY1	SFMSWY2	SFMSWY3	SFMECSWY1
J1					
J1					
J1					
J1					
A2					
A2					
A2					
A2					
R3					
R3					
R3	0.3	1	1.2	0.9	1.8
R3	0.4	0.9	0.8	0.7	1.2
S4					
S4					
S4	2.7	1.7	1.4	2.6	2.5
S4	1.4	1.8	1.4	1.8	1.8
J5	0.5	1.1	1.5	0.9	
J5	0.3	1	1.8	1.7	3
J5	0.3	1.3	1.2	1	2.1
J5	0.6	1	1.4	1.6	3
G6		3.3	3.1		4.8
G6	3.9	3.9	5.9		4.6
G6					
G6					
B7	1.4	2.2	4		1.5
B7	2.8	2.6	2.8	2.5	2.9
B7	1.5	1.7	2.1	1.8	4.3
B7	1.3	3.9	2	2.5	2.7
S8	0.8	0.7	1.2	1.1	1.8
S8	0.5	1.1	1	0.9	2.2
S8	0.6	1	0.7	0.6	2
S8	0.5	1	0.9	1.2	2.3
C9		2.2	2.5	2.9	2.1
C9		4.7	4.7	5.9	3.1
C9	5.2	3	3.8	2.7	4.6
C9	3.4	3.5	3.8	3.7	4.1
A10	0.3	0.7	0.7	0.5	1.3
A10	0.2	0.7	0.6	0.4	1.6
A10	0.5	0.6	0.4	0.2	1.2
A10	0.6	0.5	0.5	0.5	0.8
R11	0.3	0.9	1	1.1	2.1

ID	SFECSWY3	SFMSWY1	SFMSWY2	SFMSWY3	SFMECSWY1
R11	0.3	1.2	0.9	0.9	2.2
R11	0.2	0.7	0.9	0.6	1.1
R11	0.2	1.1	1.1	1	1.4
K12	0.4	1.1	0.6	0.9	1.5
K12	1.8	2.9	1	1	1.7
K12	0.7	0.7	1	1	1.3
K12	1	1.7	1.3	1.3	1.1
M13	0.6	1	0.6	0.8	2
M13	0.3	1	1.1	0.7	1.5
D14	0.6	1.3	1.3	1.1	1.5
D14	1.2	1.3	1.4	1.4	1.7
D14	0.8	1	1.2	1	2.6
D14	1.1	1	1	1.1	1.7
S15	0.5	1.4	1.2	0.8	1.5
S15	1.2	0.9	0.8	1.2	1.2
S15	0.8	0.6	0.8	0.8	1.7
S15	1	1.4	1	0.9	1.3
M16	0.7	1.2	1.3	1	1.7
M16	1.5	1.4	1.5	1.3	2
M16	0.7	1.3	1.5	1	1.5
M16	0.6	1.3	1.5	1.4	2
T17	4.9			3.4	
T17	4.6	4.3	4.3	5	
T17		3.3	4.7	4.2	3.9
T17		3.8			
S18					
S18					
S18					
S18					
D19					
D19					
D19					
D19					
E20					
E20					
E20					
E20					
B21	1	0.8	0.6	0.9	2.3
B21	0.4	0.7	0.4	0.6	2.9
B21	0.5	0.8	0.6	0.4	2.5
B21	0.3	0.9	1	1.7	2.2

ID	SFMECSWY2	SFMECSWY3	ID	SFMECSWY2	SFMECSWY3
J1			R11	1.4	1.3
J1			R11	0.8	1.5
J1			R11	1.7	1.8
J1			K12	1.1	1.1
A2			K12	2.5	1.9
A2			K12	1.2	2
A2			K12	1.9	2.1
A2			M13		
R3			M13	1.4	1.7
R3			D14	1.8	1.9
R3	1.4	1.4	D14	3.2	2.7
R3	1.1	1.2	D14	2.5	4.8
S4			D14	2	2.4
S4			S15	1.4	1.4
S4	2.7	2.9	S15	1.6	2
S4	2.3	2.2	S15	1.5	1.1
J5	3		S15	1.8	0.9
J5	2.8	2.7	M16	1.5	1.5
J5			M16	1.3	1.5
J5	3.1		M16	2.1	1.2
G6	4.7		M16	2.4	1.5
G6	5.9		T17		
G6			T17		3.2
G6			T17		
B7	2.9	3.6	T17		
B7	3.9		S18		
B7	3	5.9	S18		
B7	2.5	4	S18		
S8	1.6	3.2	S18		
S8	2.2	1.6	D19		
S8	2	2.7	D19		
S8	3.1	2	D19		
C9			D19		
C9	3.5	4.4	E20		
C9	3.7	3.4	E20		
C9	5.8	3.4	E20		
A10	1	1.1	E20		
A10	1	1.6	B21	1.5	2
A10	1.2	1.1	B21	1.9	1.6
A10	0.8	0.8	B21	1	1.7
R11	1.4	1.1	B21	1.1	1.9