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Physical Ability Requirements for the Airways Transportation Systems Specialist (ATSS) Occupation

Dana Broach, Ph.D. (retired, dana.broach@gmail.com)
Alfretia Scarborough
Aerospace Human Factors Research Division
FAA Civil Aerospace Medical Institute
Oklahoma City, OK

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16. Abstract

Airway Transportation Systems Specialists ("systems specialists;" ATSSs; FV-2101) are responsible for the maintenance, operation, and management of the technical infrastructure of the U.S. National Airspace System. Systems Specialists work in field Systems Support Centers which are organized by "specialty" based on the types of facilities, services, and equipment at a given location. There are five specialties: Automation; Communications; Navigation; Surveillance; and Environmental. **Objectives:** The first objective of this study was to describe and compare the frequency of performing physically-oriented other work activities (OWAs) in the course of their duties by specialty. Examples of OWAs include climbing ladders of various heights to reach equipment, working out-of-doors, and lifting or carrying sometimes heavy objects. These OWAs are not job tasks in and of themselves, but are performed in the course of normal ATSS duties. The second objective of this study was to describe and compare the profile of sensory, physical, and psychomotor abilities required of specialists by specialty. **Method.** Data from the ATSS Job Analysis (Broach, Vestal, Martin, Krokos, Josias, Manville, Johnson, & Scarborough, 2018) are analyzed by specialty by cross-tabulations and one-way analysis of variance by specialty. **Results.** Relatively speaking, specialists in the Environmental specialty perform some physically-oriented other work activities such as crouching, working outside, climbing short (less than 8 foot) ladders, and working with arms overhead, somewhat more often than specialists at other SSC types. Automation is the least physically demanding specialty. The other specialties fall in between these two poles. Performing these other work activities requires specialists to possess abilities such as sight, hearing, and strength at the time of hire. There were no differences by SSC type in the importance of 27 of 31 physical, sensory, and psychomotor abilities, however, all 31 of the physical, sensory, and psychomotor abilities were rated by 70% or more of the job analysis participants as needed at the time of hire. **Conclusions.** The ATSS job is characterized by moderate physical demands in the course of performing maintenance tasks. Specialty-specific physical, psychomotor, and sensory ability profiles are not required for the ATSS occupation.

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Physical Ability Requirements for the Airways Transportation Systems Specialist (ATSS) Occupation

The Federal Aviation Administration (FAA) Technical Operations Services manages, operates, and maintains the facilities, services, and equipment that comprise the U.S. National Airspace System (NAS). That technical infrastructure has over 30,000 individual components, ranging from runway lights to radios to sophisticated computer networks spanning the nation. Over 35,000 flights per day rely upon the availability and accuracy of the navigational and communications services provided by the Technical Operations Service.

To accomplish this mission, the Technical Operations Services employs about 4,400 Airway Transportation Systems Specialists (ATSSs or "technicians," FV-2101) at Systems Support Centers (SSCs) across the country. Many SSCs are co-located with an air traffic control facility and maintain the equipment and services associated with that particular facility. Others serve multiple and geographically dispersed facilities, services, and equipment. ATSSs at field SSCs install, maintain, repair, operate, monitor, and certify the hardware, software, and services that enable safe and efficient flight operations in the NAS.

In the course of performing maintenance and repair on the facilities, services, and equipment (FSEs) comprising the technical infrastructure of the NAS, technicians may be required to engage in physical activities. The range of physical demands appears to be substantial across the NAS and are reflected in the description of the responsibilities and requirements of the position (see Appendix A).

For example, an ATSS might be required to climb a radio mast in the course of servicing a Remote Communications Antenna Group (RCAG). Another ATSS might have to crawl under a raised floor to reach a critical cabling junction behind a bank of controller workstations at an air route traffic control center (ARTCC). Similarly, another ATSS might have to work with arms extended overhead while standing on an 8-foot ladder for an extended period to service the heating, ventilation, and air conditioning (HVAC) system in a tower cab. The purpose of this study is to document the range of physical ability requirements, overall and by specialty, in the ATSS occupation.

The FAA assigns each facility, service, or equipment to one of five broad categories or classes, termed "specialty" in this report: Automation; Communication; Environmental; Navigational Aids, and Surveillance. The Automation specialty encompasses operations and maintenance of the computers, displays, and within-facility networks supporting controller workstations and flight data processing. The Communications specialty includes radios, inter-facility phone systems, antennas and transmission towers and can include between-facility

communications networks. The Environmental specialty provides operations and maintenance of the physical plant itself, such as heating, ventilation and air conditioning, power conditioning and distribution, and lighting systems. The Navigational Aids specialty encompasses operations and maintenance of equipment used for aerial navigation such as Variable Omnidirectional Radios (VORs), Distance Measuring Equipment (DME), and airport approach lighting systems. The Surveillance specialty is responsible for the operation and maintenance of air and surface radars, secondary beacons, and more recently, Global Positioning Satellite (GPS) transceivers.

SSCs are classified or labeled in terms of the primary or dominant FSEs for which the unit is responsible. For example, an SSC that is assigned FSEs for mostly automation systems of an ARTCC is classified as an "Automation SSC." A different SSC, say supporting an airport traffic control tower (ATCT) at a major airport, might be responsible for a mix of equipment including an Instrument Landing System [(ILS) in the Navigation specialty], an Airport Surveillance Radar [(ASR) in the Surveillance specialty], and heating, ventilation, and air conditioning (HVAC) systems in the tower itself (in the Environmental specialty). That SSC would be classified as "Navigation-Surveillance-Environmental" multi-specialty SSC. In other words, the FSEs serviced and maintained by a particular SSC drives its classification.

The research question, therefore, was to determine the degree physical requirements varied across the specialties in this safety- and mission-critical occupation. In this study, recently collected ATSS job/task analysis data were analyzed (Broach, Vestal, Martin, Krokos, Josias, Manville, Johnson, & Scarborough, 2018) to describe the physical requirements of ATSS work and to determine the degree to which those requirements vary across specialties. First, differences were examined in the *demand* for physical abilities by SSC type in terms of other work activities such as walking, carrying, lifting, bending, etc. in the course of performing maintenance tasks. Second, differences in the physical abilities required to perform maintenance tasks by SSC type were examined.

Method

Participants

Data collected from 1,649 non-supervisory ATSSs assigned to fields SSCs who participated in a previous job task analysis were used for this study (Broach et al., 2018). The ATSSs were categorized or classified into five broad specialty groupings based on their assigned field SSCs: Automation (AUTO; N = 115), Communication (COMM; N = 106), Navigational Aids (NAV; N = 40), Surveillance (SURV; N = 57), and Environmental (ENV; N = 330). Additionally, two mixed-specialty groups (a combination of any of the specialties): Multi-Specialty with no Environmental work component (MULTI–ENV; N = 384) and Multi-Specialty with an Environmental work component (MULTI+ENV; N = 617) were included in the analyses.

Instrument

The 2101 Job Analysis Survey included 176 work statements rated on two dimensions (frequency and importance), 344 KSA statements rated on three dimensions (importance, mastery, and needed day 1 on the job), and 29 other work activities (OWAs) rated on a single dimension (frequency). Because of the length of the survey, it was divided into two forms such that each respondent rated about half (with some overlap) of the work statements, KSA statements, and OWAs. This analysis focuses on the OWAs (Table 1) and the subset of the KSA statements representing sensory, physical, and psychomotor abilities (Table 2).

OWAs are behaviors required of ATSSs in the course of performing tasks, but are not work tasks in and of themselves. For example, an ATSS might be required to walk across some distance of uneven or rough terrain to reach a specific piece of equipment in the field before servicing it. The ATSS might have to carry a toolbox, weighing less than 50 pounds, while walking to the equipment. Servicing the equipment might require the ATSS to crouch next to the equipment in a cramped space. In this example, walking and crouching are required in the course of servicing the equipment but are not the actual task itself. Similarly, an ATSS might be required to work outdoors in cold or hot environmental conditions, depending on the season, in the course of servicing that facility or particular piece of equipment. The OWAs were designed to cover the broad range of physical activities likely to be required of an ATSS in the course of performing the core and essential functions of the job. Survey participants were asked how frequently they performed the OWAs on an eight-point scale (Figure 1).

The KSA statements were derived from Fleishman's taxonomy of sensory, psychomotor, and physical abilities (Fleishman & Quaintance, 1984; Fleishman, 1992). The ability statements were rated on how important the ability was to successful overall job performance and whether the ability was needed on the first day on the job (Figure 2).

(Frequency) **On average, how frequently do you perform this other work activity?**

0=I don't perform this task
1=Annually
2=Semi-annually
3=Quarterly
4=Monthly
5=Weekly
6=Daily
7=Hourly

Figure 1: Frequency rating scale

(Importance) **How important is this KSA for doing the ATSS job overall at your SSC?**

1=Not important
2=Somewhat important
3=Important
4=More important
5=Extremely important

(Needed on Day 1) **Is this KSA needed on the first day on the job with the FAA as a systems specialist at a SSC?**

No=This KSA is NOT needed on the first day as an ATSS at a SSC and will be learned on the job or in FAA training
Yes=This KSA IS needed on the first day as a systems specialist at a SSC and should have already been learned or developed before hire

Figure 2: Ability rating scales

Procedure

Nine cognitive OWAs (reading and various types of calculating) were excluded from the analysis, as the focus was on the physical requirements of the ATSS job. First, the proportion of respondents who performed each physically-oriented OWA on a monthly or more often basis (with 1=*monthly or more often)* and 0=*quarterly or less often*) by single-specialty SSC type via cross-tabulation. Next, if the overall χ^2 from the cross-tabulation was significant, pairwise comparisons of the proportions performing was conducting using the OWA on a monthly or more often basis by single-specialty SSC types using a standard *Z*-test of proportions. Third, a one-way analyses of variance (ANOVA) of the frequency ratings of OWAs by SSC type with post-hoc multiple comparisons using the Games-Howell test (Sauder and DeMars, 2019) was calculated.

After the proportions analysis, an analysis of the ability ratings - importance to the job overall and whether needed on Day 1 of employment as an ATSS was conducted. Mean ratings on these two dimensions by specialty were compared using one-way ANOVA with Games-Howell post-hoc multiple comparisons. This analysis provided the basis for characterizing the physical abilities required on the first day on the job at single-specialty SSCs.

The analyses were repeated for multi-specialty SSCs with and without an Environmental component, starting with the proportion performing the physically-oriented OWAs. As there were only two groups (Multi-specialty with Environmental and Multi-specialty without Environmental), a computed Z-test to compare the proportions performing each physically-oriented OWA was utilized. Finally, a one-way ANOVA of the frequency ratings by group (MULTI+ENV, MULTI–ENV) without post-hoc comparisons was calculated. All statistical analyses were performed with SPSS v24.

Table 1: Physically-oriented Other Work Activities

ID	Description
OthAct.1	Climb a near-vertical ladder less than 30 feet tall to reach equipment?
OthAct.2	Climb a near-vertical 30 foot or taller ladder to reach equipment?
OthAct.3	Stand in a bucket lift to reach equipment?
OthAct.4	Stand on a movable, adjustable platform lift to reach equipment?
OthAct.5	Climb stairs to reach equipment?
OthAct.6	Use a portable ladder of less than 8 feet to reach equipment?
OthAct.7	Lift anything weighing 50 pounds or less (including tools, tool bags, equipment, parts, etc.)?
OthAct.8	Carry anything weighing less than 50 pounds?
OthAct.9	Lift anything weighing more than 50 pounds (including tools, tool bags, equipment, parts, etc.)?
OthAct.10	Carry anything weighing more than 50 pounds?
OthAct.11	Walk across uneven, rough, or unfinished surfaces to reach equipment?
OthAct.12	Crouch, stoop, or kneel to reach equipment?
OthAct.13	Crawl or creep (around, under, through equipment or false floors) to reach equipment?
OthAct.14	Work in cramped or tightly confined equipment spaces?
OthAct.15	Bend, twist, and/or reach into and hold an unusual body position to reach and/or work on equipment?
OthAct.16	Work in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask?
OthAct.17	Work out of doors?
OthAct.18	Work in extreme temperatures (heat or cold)?
OthAct.19	Work in poorly illuminated spaces requiring use of supplemental task lighting?
OthAct.20	Work with raised arms, reaching overhead, for extended periods of time (20 minutes or more)?

Table 2: Physical, sensory, and psychomotor abilities

ID	Description
Ab01.1	Far Vision: The ability to see details at a distance
Ab01.2	Near Vision: The ability to see details at close range (i.e., within a few feet of the observer)
Ab01.3	Depth Perception: The ability to judge which of several objects is closer or farther away from you, or distance between you and an object
Ab01.4	Peripheral Vision: The ability to see objects or the movement of objects to the side when your eyes are looking ahead
Ab01.5	Night Vision: The ability to see under low light conditions
Ab01.6	Glare Tolerance: The ability to see objects in the presence of glare or lighting that is bright relative to surroundings
Ab01.7	Color Detection: The ability to identify colors
Ab01.8	Color Discrimination: The ability to differentiate between colors (e.g., shades, brightness)
Ab01.9	Auditory Detection: The ability to detect sounds across a range of frequencies and volumes
Ab01.10	Auditory Discrimination: The ability to differentiate between sounds that vary in pitch and loudness
Ab01.11	Auditory Attention: The ability to focus on a single source of sound in the presence of other distracting sounds
Ab01.12	Sensory Abilities-Sound Localization: The ability to discern the direction from which a sound originated
Ab01.13	Olfactory Discrimination: The ability to differentiate between odors
Ab01.14	Tactile Discrimination: The ability to differentiate between tactile sensations (e.g., temperature, vibration)
Ab01.15	Proprioception: The ability to sense the relative position of your body parts and the strength of effort being used
Ab01.16	Haptic Identification: The ability to identify objects through the sense of touch
Ab07.1	Trunk Strength: Ability to use abdominal & lower back muscles to support part of the body repeatedly over time without becoming fatigued
Ab07.2	Static Strength: The ability to exert maximum muscle force to lift, push, pull, or carry objects
Ab07.3	Dynamic Strength: Ability to exert muscle force repeatedly or continuously over time
Ab07.4	Dynamic Flexibility: The ability to quickly and repeatedly bend, stretch, twist, or reach out with your body, arms, and/ or legs
Ab07.5	Extent Flexibility: The ability to bend, stretch, twist, or reach with your body, arms, and/ or legs
Ab07.6	Dynamic Body Coordination: The ability to coordinate the movement of your arms, legs, and torso together when the whole body is in motion
Ab07.7	Gross Body Equilibrium: The ability to keep or regain your body balance or stay upright when in an unstable position
Ab07.8	Stamina: The ability to exert yourself physically over long periods without getting winded or out of breath
Ab08.1	Manual Dexterity: Ability to move your hand, your hand together with your arm, or your two hands to grasp/manipulate/assemble objects

ID	Description
Ab08.2	Finger Dexterity: Ability to make coordinated movements of fingers of one/both hands to grasp, manipulate, or assemble very small objects
Ab08.3	Arm-Hand Steadiness: The ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position
Ab08.4	Precise Use of Controls: The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions
Ab08.5	Multi-Limb Coordination: Ability to coordinate two or more limbs while sitting, standing, or lying down
Ab08.6	Motor Coordination: The ability to coordinate movements with sensory stimulus
Ab08.7	Response to Competing Stimuli: Ability to choose an appropriate action in response to two or more different stimuli

Results

Other Work Activities

Overall.

The percentage of respondents who indicated not performing each OWA, the percentage performing it quarterly or less frequently, and the percentage performing the OWA monthly or more frequently are presented in Figure 3. The mean frequency rating (*M* (Freq)) and the standard deviation (*SD* (Freq)) of the ratings for persons who performed the OWA were also calculated. Overall, descriptive statistics of ratings of the frequency of performing OWAs are presented in Appendix B along with bar charts illustrating the distribution of ratings.

At least 50% of respondents indicated performing 12 of the 20 other work activities at least monthly. Over 90% of 532 respondents indicated climbing stairs to reach equipment on a monthly or more often basis. The next most commonly performed OWAs (at least monthly) was carrying anything weighing less than 50 pounds (88.6%), and walking across rough or uneven ground (88.5%). Over 70% of respondents indicated working in extreme temperatures (78.8%) and in poorly illuminated spaces requiring use of task lighting (75.0%). Over 60% of respondents reported performing OWAs on at least a monthly basis: crawling or creeping around to reach equipment (67.9%), climbing near vertical ladders less than 30 feet tall (67.4%), crouching kneeling, or stooping (61.7%), climbing near-vertical ladders 30-foot or higher ladders (61.7%), and bending, twisting or kneeling to reach equipment (60.2%). A majority reported working out of doors monthly or more often (55.7%) and lifting objects weighting 50 pounds or less (55.6%).

A plurality of respondents indicated using portable ladders of less than 8 feet (48.8%) or standing in a bucket lift to reach equipment on a monthly or more often basis

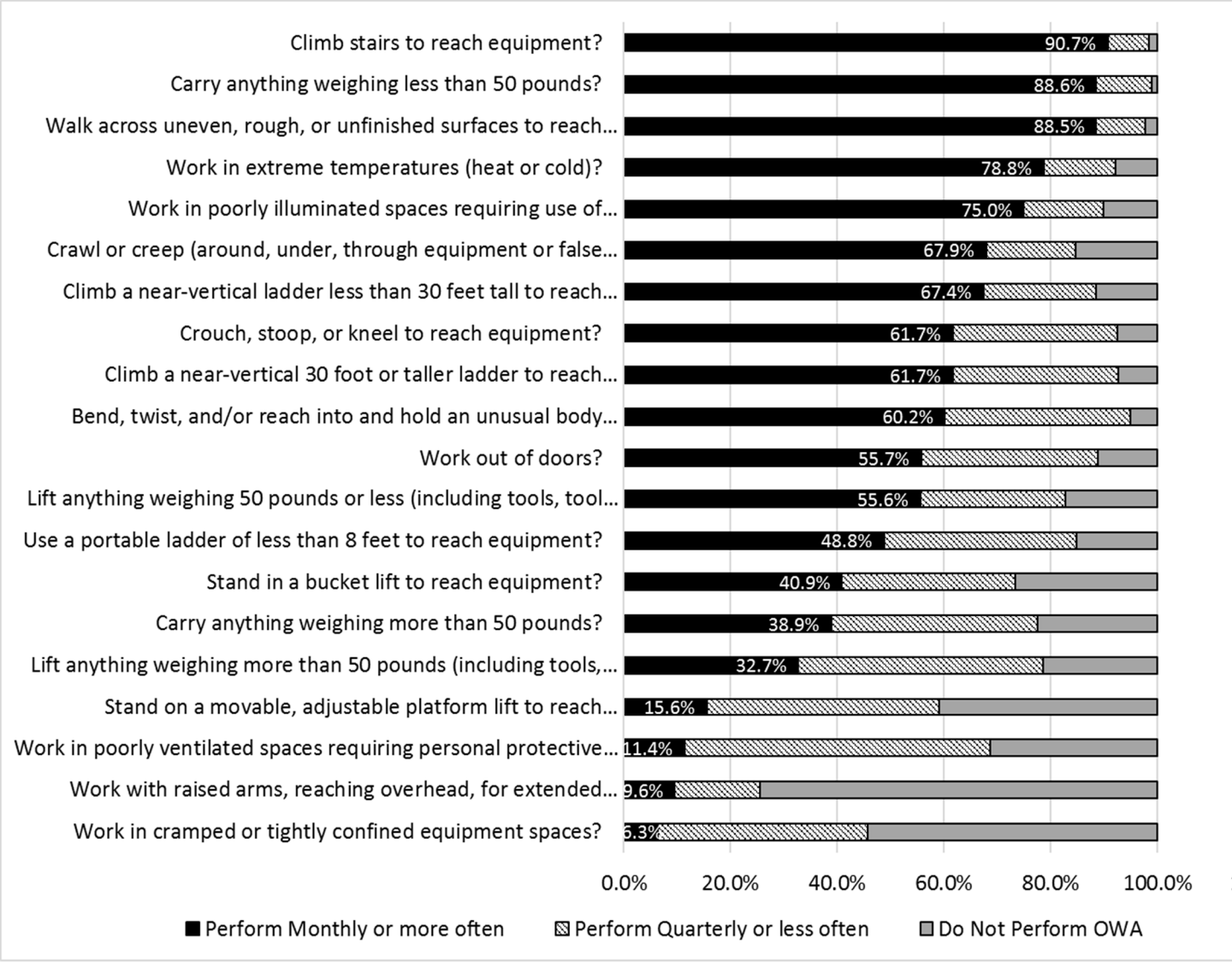

Figure 3: Percent performing each OWA

(40.9%). Lifting or carrying objects weighing more than 50 pounds was less commonly performed monthly or more often (38.9% and 32.7% respectively). The least commonly performed OWAs were standing on platform lifts to reach equipment (15.6%), working in poorly ventilated spaces requiring personal protective equipment (11.4%), working with raised arms overhead for extended periods (9.6%), and working in tight or confined spaces (6.3%).

Overall, it appears that the ATSS job is characterized by moderate physical demands in line with other maintenance-oriented occupations. However, there is substantial variation in the proportions of ATSSs performing these physically-oriented OWAs. It might be the case that the variability in the frequency of performing physically-oriented work activities is a function of SSC type. Climbing 30-foot or taller vertical ladders, for example, might be frequent for ATSSs at Communications SSCs but never done in Automation SSCs. Therefore, further investigation into the degree to which the frequency of performing these other physical work activities varied by specialty (SSC type) was required.

By single-specialty SSC types.

The proportions of participants performing physically-oriented work activities on a monthly or more often basis were compared by specialty in several steps. The proportions performing an OWA by single-specialty type are presented in Table 3. The first step was to cross-tabulate the frequency indicator (where 0=*Performed other work activity quarterly or less often*, 1=*Performed the other work activity monthly or more often*) by SSC type. The overall $\chi 2$ was computed to determine if there was an association between performing physically-oriented OWAs and SSC type (specialty). The second step, if and only if the overall χ^2 was significant for a specific OWA, was a pairwise comparison of the proportions performing the other work activity monthly or more often by SSC type using a standard *Z*-test of proportions. For example, if the χ^2 for the cross-tabulation of SSC type by the frequency of lifting anything weighing 50 pounds or less (OthAct.7) was statistically significant ($\chi^2 = 35.13$, $p < .001$), then we proceeded to the pairwise comparison of proportions (AUTO versus COMM, AUTO versus NAV, etc. for 10 pairwise comparisons). Continuing with the example, 87.8% of the specialists assigned to Automation (AUTO) SSCs indicated lifting objects of 50 pounds (or less than 50 pounds) on a monthly (or more often) basis compared to 85% of specialists at Communication (COMM) SSCs. These proportions were not significantly different (Z=0.38, *ns*).

The results of the analysis of other work activities by single-specialty (SSC type) are summarized in Table 4. The picture that emerges is that, on one hand, the physically-oriented OWAs are performed less frequently by specialists assigned to Automation SSCs in comparison to the other SSC types. On the other hand, physically-oriented OWAs appear to be performed more frequently by specialists assigned to Environmental SSCs, in comparison to the other four SSC types. The other single-specialty SSC types – Communications, Navigation, and Surveillance – fall in the middle in terms of the frequency of performance of the OWAs, with no significant differences between Navigation and Communications in terms of the proportions of specialists indicating performing any OWA on a monthly basis or more often.

Table 3: Proportion of systems specialists performing an Other Work Activity monthly or more often for single-specialty SSCs

OWA ID	Description	AUTO	COMM	NAV	SURV	ENV
OthAct.7	Lift anything weighing 50 pounds or less (including tools, tool bags, equipment, parts, etc.)?	87.8%	91.9%	72.2%	94.4%	93.0%
OthAct.8	Carry anything weighing less than 50 pounds?	85.2%	83.9%	60.0%	84.2%	92.4%
OthAct.9	Lift anything weighing more than 50 pounds (including tools, tool bags, equipment, parts, etc.)?	64.3%	54.5%	64.7%	66.7%	74.0%
OthAct.10	Carry anything weighing more than 50 pounds?	61.5%	40.0%	40.0%	70.6%	76.0%
OthAct.11	Walk across uneven, rough, or unfinished surfaces to reach equipment?	71.4%	51.9%	81.3%	76.9%	85.4%
OthAct.12	Crouch, stoop, or kneel to reach equipment?	96.2%	93.5%	60.0%	100.0%	91.4%
OthAct.13	Crawl or creep (around, under, through equipment or false floors) to reach equipment?	53.1%	52.0%	60.0%	40.0%	69.7%
OthAct.14	Work in cramped or tightly confined equipment spaces?	56.5%	65.2%	71.4%	57.1%	73.7%
OthAct.15	Bend, twist, and/or reach into and hold an unusual body position to reach and/or work on equipment?	52.6%	57.1%	71.4%	50.0%	76.2%
OthAct.16	Work in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask?	20.0%	40.0%	50.0%	33.3%	43.5%
OthAct.20	Work with raised arms, reaching overhead, for extended periods of time (20 minutes or more)?	50.0%	56.3%	50.0%	42.9%	69.6%
OthAct.1	Climb a near-vertical ladder less than 30 feet tall to reach equipment?	64.3%	26.9%	31.3%	40.0%	60.7%
OthAct.2	Climb a near-vertical 30 foot or taller ladder to reach equipment?	0.0%	0.0%	11.1%	27.3%	25.6%
OthAct.5	Climb stairs to reach equipment?	84.2%	76.5%	71.4%	81.3%	86.4%
OthAct.6	Use a portable ladder of less than 8 feet to reach equipment?	60.0%	70.4%	44.4%	62.5%	83.0%
OthAct.3	Stand in a bucket lift to reach equipment?	33.3%	37.5%	20.0%	25.0%	20.9%
OthAct.4	Stand on a movable, adjustable platform lift to reach equipment?	55.6%	40.0%	0.0%	40.0%	34.1%
OthAct.17	Work out of doors?	42.9%	42.9%	100.0%	75.0%	93.8%
OthAct.18	Work in extreme temperatures (heat or cold)?	14.3%	57.1%	50.0%	53.3%	72.2%
OthAct.19	Work in poorly illuminated spaces requiring use of supplemental task lighting?	83.3%	81.3%	60.0%	53.3%	83.3%

Table 4: Summary of Z-test results for comparing proportions performing Other Work Activity monthly or more often for single-specialty SSCs

	AUTO	COMM	NAV	SURV
COMM	**COMM > AUTO** OthAct.10 Carry>=50# OthAct.17 Work out of doors			
NAV	**NAV>AUTO** OthAct.11 Walk on uneven surface OthAct.12 Crouch, stoop, etc. OthAct.17 Work out of doors	**NAV>COMM** OthAct.11 Walk on uneven surface OthAct.17 Work out of doors		
SURV	**SURV>AUTO** OthAct.10 Carry>=50# OthAct.2 Climb ladder >=30 foot OthAct.17 Work out of doors	**SURV>COMM** OthAct.2 Climb ladder >=30 foot OthAct.17 Work out of doors	*nsd*	
ENV	**ENV>AUTO** OthAct.11 Walk on uneven surface OthAct.12 Crawl or creep OthAct.15 Bend, twist, reach OthAct.20 Raised arms OthAct.1 Climb ladder < 30 feet OthAct.2 Climb ladder >=30 foot OthAct.5 Climb stairs OthAct.6 Portable ladder OthAct.3 Stand in lift bucket OthAct.17 Work out of doors	**ENV>COMM** OthAct.14 Cramped or confined work spaces OthAct.15 Bend, twist, reach OthAct.20 Raised arms OthAct.1 Climb ladder < 30 feet OthAct.2 Climb ladder >=30 foot OthAct.5 Climb stairs OthAct.6 Portable ladder OthAct.17 Work out of doors	**ENV>NAV** OthAct.7 Lift < 50# OthAct.8 Carry < 50# OthAct.9 Lift >= 50# OthAct.5 Climb stairs OthAct.6 Portable ladder	**ENV>SURV** OthAct.11 Walk on uneven surface OthAct.14 Cramped or confined work spaces OthAct.15 Bend, twist, reach OthAct.20 Raised arms OthAct.6 Portable ladder OthAct.17 Work out of doors

Notes: *nsd*=no significant differences

There also appear to be relative differences in the kinds of physically-oriented OWAs by SSC type as shown in Table 4. For example, specialists in Communications, Navigation, Surveillance, and Environmental SSCs indicated working outdoors more often than specialists assigned to Automation SSCs. This makes sense as computers are largely indoors, while radars, radio masts, landing lights and their associated structures are largely outdoors. Similarly, Environmental specialists indicated working with their arms overhead and climbing ladders of various sizes more frequently than ATSSs assigned to other types of SSCs. This seems reasonable as Environmental SSCs are responsible for facility heating, ventilation, and air conditioning (HVAC) and Environmental Control (EC) systems which are generally located overhead, in ceilings.

Overall, the analysis of the frequency of performance of physically-oriented OWAs by SSC type indicated that there were some significant differences between single-specialty SSC types. It appears that the SSC types might be rank-ordered in terms of performing these physically-oriented activities on a monthly basis or more often as follows (from most frequent to least frequent): ENV > (NAV = SURV) > COMM > AUTO. That is, larger proportions of specialists in Environmental-only SSCs reported performing physically-oriented OWAs on a monthly or more often basis than specialists at other types of SSCs. There were no significant differences in the proportions of specialists performing OWAs for Navigation and Surveillance SSCs. But the physical demands (in terms of how often physically-oriented OWAs were performed) for Navigation and Surveillance SSCs was greater than the physical demands at Communications-only SSCs. The proportion of participants performing these physically-oriented OWAs (on a monthly or more often basis) was smallest for the Automation-only SSCs.

Examining differences in mean ratings of frequency by SSC type provides a different perspective on the physical demands of ATSS work at single-specialty SSCs. The detailed results of that analysis is found in Appendix C. We analyzed the data via the SPSS ONEWAY ANOVA procedure with post-hoc multiple comparisons by SSC type.

Mean ratings of frequency of performance of several OWAs was consistently higher for ENV-only SSCs compared to the ratings from other single-specialty SSCs (see Appendix C for statistical details). Mean frequency rating from ENV specialists was higher than the mean ratings for the other SSC specialties for (a) working out-of-doors, (b) using a portable ladder less than 8 feet tall, and (c) bending, twisting and reaching. The mean rating of frequency of performance for ten of the 20 physically-oriented OWAs was higher for ENV SSCs than for AUTO SSCs, and for eight of the 20 OWAs in comparison to COMM SSCs. Analysis of the mean ratings of frequency, as opposed to the percentage performing an OWA monthly or more often, suggested the same general pattern of Automation SSCs having the least physical demands, in terms of these physically-oriented OWAs and Environmental SSCs having the greatest physical demands in terms of how often the physically-oriented OWAs are performed. There were few differences between COMM, NAV, and SURV SSCs in terms of mean ratings of frequency of performance of the OWAs. On average, specialists at

COMM SSCs indicated working out of doors and walking across uneven or broken ground less often than specialists assigned to NAV and SURV SSCs.

Overall, analysis of the frequency ratings showed the same pattern as discussed above: ENV > (NAV = SURV) > COMM > AUTO. That is, on average, specialists at ENV SSCs rated more OWAs as being performed more frequently than specialists at other types of SSCs. Conversely, specialists at AUTO SSCs rated most of the OWAs as performed less frequently than specialists at other types of single-specialty SSCs. The frequency ratings for COMM SSCs were higher for a few OWAs in comparison to ratings for specialists at NAV and SURV SSCs, and there were no differences between mean ratings of frequency between NAV and SURV SSCs.

Multi-specialty SSC types.

As noted in the description of the survey respondents, fewer than half of the systems specialists worked in single-specialty SSCs while 61% indicated working in SSCs with multiple specialties. These participants were categorized into two groups : multi-specialty SSCs with Environmental (MULTI+ENV) and multi-specialty SSCs without Environmental (MULTI–ENV). As in the analysis for single-specialty SSCs, the first step was to cross-tabulate the frequency indicator (where 0=*Performed other work activity quarterly or less often*, 1=*Performed the other work activity monthly or more often*) by SSC type (MULTI+ENV, MULTI–ENV), and computeχ2. If the overall χ^2 was significant for a specific OWA, the proportions performing the other work activity monthly or more often for by SSC type were compared using the standard *Z*-test of proportions. The proportions of participants performing each OWA on a monthly or more often basis by type of multi-specialty SSC (with or without ENV) are presented in Table 5.

The two multi-specialty groups were significantly different for six OWAs:

- Lifting anything more than 50 pounds (OthAct9)
- Walking across uneven, rough, or unfinished surfaces to reach equipment (OthAct11)
- Bending and twisting to reach equipment (OthAct15)
- Working outdoors (OthAct17)
- Working in extreme temperatures (OthAct18)
- Working with raised arms, reaching overhead (OthAct20)

In each case, the multi-specialty SSCs with an Environmental component group had a greater proportion of respondents performing the OWA than did the group that did not include the Environmental component.

Analysis of the frequency ratings by one-way ANOVA found significant differences in mean ratings by multi-specialty SSC type for the same six OWAs plus two additional OWAs: Crawling or creeping through equipment or under false floors (OthAct.13) and climbing ladders less than 30 feet tall (OthAct.1) (Appendix D).

Other Work Activities summary.

Overall, the physical demands for ATSSs in SSCs were greatest for specialists assigned to ENV SSCs and least for those assigned to AUTO SSCs. There were few statistically significant differences between the COMM, NAV, and SURV SSCs. ATSSs assigned to multi-specialty SSCs with an Environmental component performed eight of the OWAs more frequently than specialists at multi-specialty SSCs.

Table 5: Percent of participants performing OWA monthly or more often by multi-specialty SSC type

OWA ID	Description	MULTI–ENV	MULTI+ENV
OthAct.12	Crouch, stoop, or kneel to reach equipment?	91.8%	92.8%
OthAct.8	Carry anything weighing less than 50 pounds?	88.4%	92.7%
OthAct.7	Lift anything weighing 50 pounds or less (including tools, tool bags, equipment, parts, etc.)?	86.9%	92.7%[a]
OthAct.7	Lift anything weighing 50 pounds or less (including tools, tool bags, equipment, parts, etc.)?	86.9%	92.7%[a]
OthAct.5	Climb stairs to reach equipment?	83.6%	83.3%
OthAct.5	Climb stairs to reach equipment?	83.6%	83.3%
OthAct.17	Work out of doors?	79.0%	92.3%[a]
OthAct.17	Work out of doors?	79.0%	92.3%[a]
OthAct.11	Walk across uneven, rough, or unfinished surfaces to reach equipment?	71.2%	85.7%[a]
OthAct.11	Walk across uneven, rough, or unfinished surfaces to reach equipment?	71.2%	85.7%[a]
OthAct.19	Work in poorly illuminated spaces requiring use of supplemental task lighting?		
OthAct.19	Work in poorly illuminated spaces requiring use of supplemental task lighting?	70.8%	75.6%
OthAct.14	Work in cramped or tightly confined equipment spaces?	63.2%	68.6%
OthAct.14	Work in cramped or tightly confined equipment spaces?	63.2%	68.6%

70.8% 75.6%

OthAct.10	Carry anything weighing more than 50 pounds?	60.2%	70.7%[a]
OthAct.10	Carry anything weighing more than 50 pounds?	60.2%	70.7%[a]
OthAct.9	Lift anything weighing more than 50 pounds (including tools, tool bags, equipment, parts, etc.)?	58.3%	69.0%[a]
OthAct.9	Lift anything weighing more than 50 pounds (including tools, tool bags, equipment, parts, etc.)?	58.3%	69.0%[a]
OthAct.6	Use a portable ladder of less than 8 feet to reach equipment?	54.0%	59.8%
OthAct.6	Use a portable ladder of less than 8 feet to reach equipment?	54.0%	59.8%
OthAct.15	Bend, twist, and/or reach into and hold an unusual body position to reach and/or work on equipment?	51.4%	63.8%[a]
OthAct.15	Bend, twist, and/or reach into and hold an unusual body position to reach and/or work on equipment?	51.4%	63.8%[a]
OthAct.13	Crawl or creep (around, under, through equipment or false floors) to reach equipment?	45.3%	54.3%
OthAct.13	Crawl or creep (around, under, through equipment or false floors) to reach equipment?	45.3%	54.3%
OthAct.18	Work in extreme temperatures (heat or cold)?	43.6%	62.5%[a]
OthAct.18	Work in extreme temperatures (heat or cold)?	43.6%	62.5%[a]
OthAct.16	Work in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask?	34.8%	34.0%
OthAct.16	Work in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask?	34.8%	34.0%
OthAct.20	Work with raised arms, reaching overhead, for extended periods of time (20 minutes or more)?	34.3%	49.7%[a]
OthAct.20	Work with raised arms, reaching overhead, for extended periods of time (20 minutes or more)?	34.3%	49.7%[a]
OthAct.1	Climb a near-vertical ladder less than 30 feet tall to reach equipment?	30.2%	39.1%
OthAct.1	Climb a near-vertical ladder less than 30 feet tall to reach equipment?	30.2%	39.1%
OthAct.4	Stand on a movable, adjustable platform lift to reach equipment?	24.7%	20.0%
OthAct.4	Stand on a movable, adjustable platform lift to reach equipment?	24.7%	20.0%

OthAct.2	Climb a near-vertical 30 foot or taller ladder to reach equipment?	14.0%	15.1%
OthAct.2	Climb a near-vertical 30 foot or taller ladder to reach equipment?	14.0%	15.1%
OthAct.3	Stand in a bucket lift to reach equipment?	2.4%	10.1%
OthAct.3	Stand in a bucket lift to reach equipment?	2.4%	10.1%

[a] chi-square significant at $p<.01$

specialty SSCs without the Environmental component. The results demonstrate that

- All ATSSs engage in physically-oriented work activities, even if infrequently and the job is characterized by moderate physical demands.
- ATSSs whose responsibilities include Environmental FSE perform some physically-oriented work activities more often than ATSSs assigned to other specialties

Abilities

The next set of analyses focuses on the importance of physical, sensory, and psychomotor abilities required to perform the systems specialist duties successfully and the degree of variation by SSC type.

As in the analysis of the physical requirements, a multi-step approach was used in evaluating both importance and whether an ability is required on the first day on the job. The first step was to evaluate the proportion of respondents marking an ability as "more important" or "very important" (p(Imp)) and the proportion marking the ability as required on day one (p(Day1)) overall and by SSC type. The second step was to evaluate differences in the mean ratings of ability importance by SSC type. The first analysis takes into consideration the distribution of ratings, while the second considers the overall average.

Overall.

Descriptive statistics on respondents' identification of importance and the need to have the ability at job entry are reported in Appendix E.

Just nine of the thirty-one physical, sensory, and psychomotor abilities were endorsed by 50% of more of respondents to the job analysis survey as *More Important* or *Extremely Important* to successful performance of the ATSS job. Four of the nine were related to vision: Color Detection; Color Discrimination; Near Vision; and Depth Perception while and additional four were related to manual dexterity: Finger Dexterity; Manual Dexterity; Precise Use of Controls; and Arm-Hand Steadiness. The remaining single Response to Competing Stimuli - the ability to choose an appropriate action in response to two or more different stimuli, e.g., lights, sounds, pictures (see Figure 4). In contrast, all 31 physical, sensory, and psychomotor abilities were evaluated as needed on the first day on the job by 70% or more of the respondents (Figure 5). Given that *abilities* are considered innate to a person, possessing these abilities at the time of hire is reasonable.

By single-specialty SSC types.

As in the analysis of OWAs, we first examined the proportions of participants marking an ability as *More* or *Extremely Important* to successful job performance by single-specialty SSC type via cross-tabulation and the χ^2 test. If the $\chi 2$ was significant, the proportions between single-specialty SSC type using the standard *Z*-test for proportions. Second, the importance ratings were analyzed for each physical, sensory, and psychomotor ability by single-specialty SSC type with

one-way ANOVA with post-hoc multiple comparisons to answer the question "To what degree does the importance of an ability vary across single-specialty SSC type?" The overall ANOVA *F*-test indicates the presence or absence of variability across SSC types; the post-hoc multiple comparisons identifies which SSC types differ statistically in their ratings of the importance of an ability.

The percent of participants marking an ability as *More* or *Extremely Important* is presented in Table 6 by single-specialty SSC type. The cross-tabulation analysis indicated statistically significant differences in the proportions of participants rating an ability as *More* or *Extremely Important* for just six out of the 31 abilities (see Table 7):

- Auditory Detection (Ab01.9)
- Auditory Discrimination (Ab01.10)
- Olfactory Discrimination (Ab01.13), Stamina (Ab07.8)
- Precise Use of Controls (Ab08.4)
- Response to Competing Stimuli (Ab08.7).

Larger proportions of specialists at COMM (58%) and ENV (47%) single-specialty SSCs rated Auditory Detection as More or Very Important than specialists at AUTO (38%) or NAV (18%) single-specialty SSCs. Larger proportions of specialists at COMM (58%) and ENV (47%) single-specialty SSCs rated Auditory Discrimination as More or Very Important than specialists at NAV (12%) single-specialty SSCs (Z=3.19, $p<.05$ for the COMM-NAV comparison, and Z=2.77, $p<.05$ for the ENV-NAV comparison). The proportion of specialists at ENV-only SSCs rated Olfactory Discrimination as More or Very Important (48%) compared to specialists at COMM-only SSCs (26%; Z=2.32, $p<.05$). A larger proportion of specialists at COMM SSCs rated Stamina as More or Very Important (38%) than specialists at AUTO SSCs (9%; Z=2.42, $p<.05$). While the overall χ^2 was significant for Precise Use of Controls ability, there were no statistical differences in the pairwise comparisons by single-specialty SSC type. Finally, 60% of specialists at ENV-only SSCs rated Response to Competing Stimuli as More or Very Important, compared to 35% of specialists at COMM-only SSCs (Z=2.44, $p<.05$).

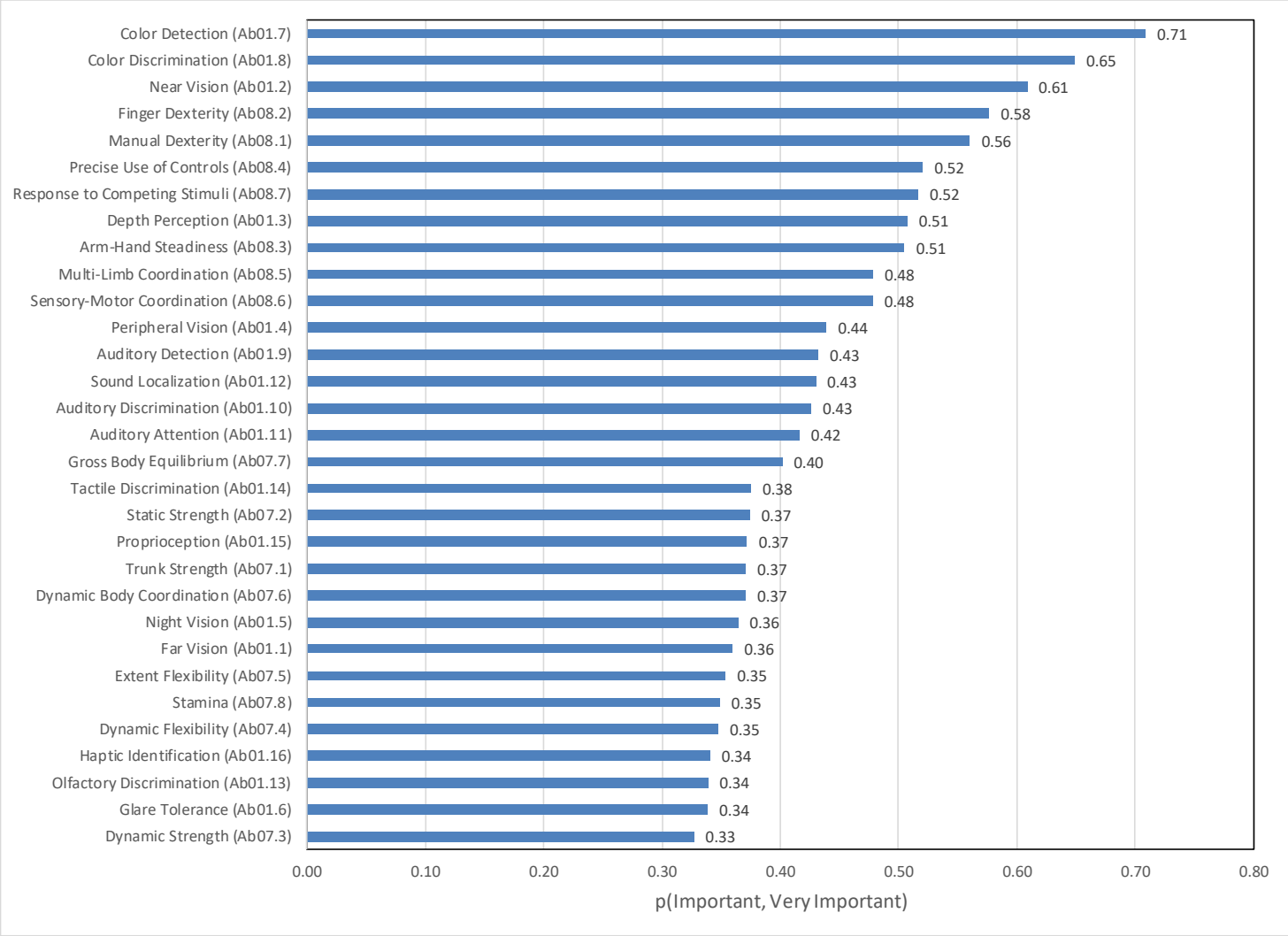

Figure 4: Overall proportions rating ability important or very important to job performance

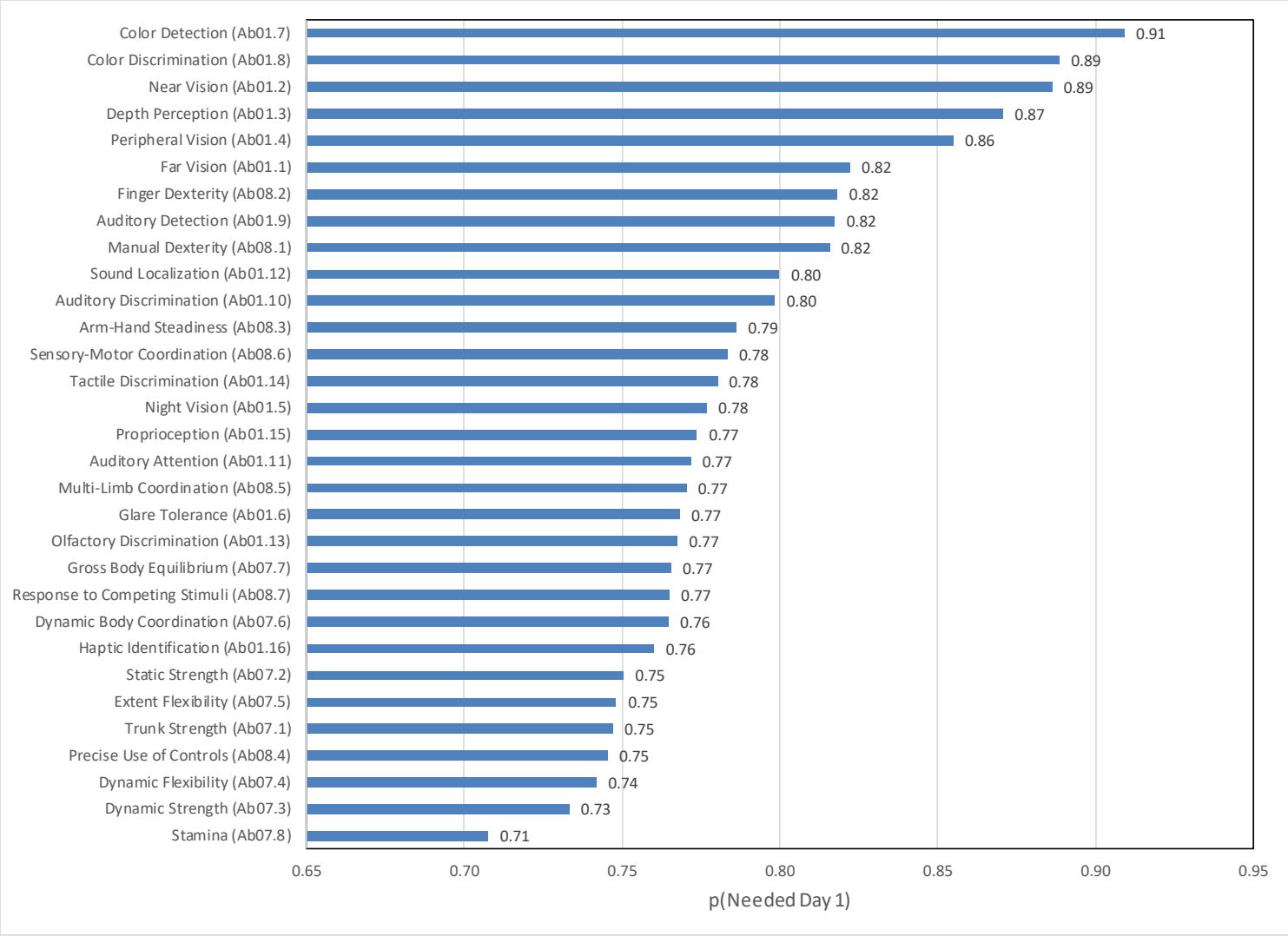

Figure 5: Overall proportion rating ability as needed on Day 1 of employment (at hire) (sorted from high to low)

Table 6: Percent rating Ability as More or Extremely Important to successful job performance by single-specialty SSC type

ID	Description	AUTO	COMM	NAV	SURV	ENV
Ab01.1	Far Vision	25.5%	29.7%	35.3%	31.3%	43.7%
Ab01.2	Near Vision	63.0%	56.8%	52.9%	50.0%	61.1%
Ab01.3	Depth Perception	41.3%	48.6%	35.3%	33.3%	56.3%
Ab01.4	Peripheral Vision	37.0%	43.2%	35.3%	40.0%	52.4%
Ab01.5	Night Vision	45.7%	32.4%	23.5%	20.0%	44.4%
Ab01.6	Glare Tolerance	30.4%	25.0%	29.4%	20.0%	43.7%
Ab01.7	Color Detection	65.2%	56.8%	62.5%	56.3%	77.8%
Ab01.8	Color Discrimination	62.2%	54.1%	52.9%	46.7%	69.8%
Ab01.9	Auditory Detection	34.8%	57.9%	17.6%	31.3%	50.4%
Ab01.10	Auditory Discrimination	39.1%	57.9%	11.8%	31.3%	47.2%
Ab01.11	Auditory Attention	41.3%	44.7%	11.8%	33.3%	48.8%
Ab01.12	Sound Localization	41.3%	52.6%	35.3%	20.0%	47.2%
Ab01.13	Olfactory Discrimination	32.6%	26.3%	25.0%	26.7%	47.6%
Ab01.14	Tactile Discrimination	32.6%	31.6%	17.6%	33.3%	47.2%
Ab01.15	Proprioception	32.6%	29.7%	29.4%	33.3%	48.0%
Ab01.16	Haptic Identification	34.8%	29.7%	11.8%	33.3%	43.1%
Ab07.1	Trunk Strength	21.7%	39.3%	20.0%	42.1%	40.2%
Ab07.2	Static Strength	21.7%	34.5%	20.0%	42.1%	40.2%
Ab07.3	Dynamic Strength	13.0%	37.9%	10.0%	36.8%	35.9%
Ab07.4	Dynamic Flexibility	17.4%	34.5%	20.0%	36.8%	40.2%
Ab07.5	Extent Flexibility	17.4%	34.5%	20.0%	42.1%	39.1%
Ab07.6	Dynamic Body Coordination	18.2%	37.9%	10.0%	36.8%	40.2%
Ab07.7	Gross Body Equilibrium	18.2%	34.5%	30.0%	42.1%	47.8%
Ab07.8	Stamina	8.7%	37.9%	11.1%	36.8%	42.4%
Ab08.1	Manual Dexterity	39.1%	37.9%	50.0%	63.2%	63.0%
Ab08.2	Finger Dexterity	43.5%	37.9%	50.0%	63.2%	63.0%
Ab08.3	Arm-Hand Steadiness	43.5%	34.5%	30.0%	57.9%	57.6%
Ab08.4	Precise Use of Controls	26.1%	42.9%	50.0%	57.9%	62.0%
Ab08.5	Multi-Limb Coordination	39.1%	44.8%	30.0%	63.2%	54.3%
Ab08.6	Sensory-Motor Coordination	34.8%	37.9%	30.0%	61.1%	58.9%
Ab08.7	Response to Competing Stimuli	36.4%	34.5%	30.0%	57.9%	60.4%

Overall, the analyses demonstrated statistical differences in importance of abilities between some SSC types for just five abilities (see Appendix F):

- Far Vision (Ab01.1)
- Glare Tolerance (Ab01.6)

- Auditory Detection (Ab01.9)
- Auditory Discrimination (Ab01.10)
- Tactile Discrimination (Ab01.14).

In post-hoc comparisons, the mean rating of the importance of Far Vision (Ab01.1) by specialists at AUTO-only SSCs (M=2.87) was significantly lower than the mean rating by specialists at ENV-only SSCs (M=3.41) at the conventional p<.05 level. The mean ratings of the importance of Auditory Detection (Ab01.9) for specialists at NAV-only (M=2.82) and AUTO-only (M=3.02) SSCs were statistically less than the mean rating of importance from specialists at COMM-only SSCs (M=3.71, p<.05). Mean ratings of the importance of Auditory Discrimination from specialists at NAV-only SSCs (M=2.76) were statistically less than the mean rating given by specialists from COMM-only SSCs (M=3.66, p<.01). Unsurprisingly, the mean rating of the importance of Stamina given by specialists assigned to ENV-only SSCs (M=3.28) was statistically greater than the mean rating of Stamina's importance given by specialists from AUTO-only SSCs (M=2.48, p<.01).

Table 7: Summary of Z-test results for comparing proportions marking Ability as Very or Extremely Important by single-specialty SSCs

	AUTO	COMM	NAV	SURV
COMM	**COMM > AUTO** Ab01.9 Auditory Detection Ab07.8 Stamina			
NAV	*nsd*	**NAV<COMM** Ab01.9 Auditory Detection Ab01.10 Auditory Discrimination		
SURV	*nsd*	*nsd*	*nsd*	
ENV	*nsd*	**ENV>COMM** Ab08.7 Response to Competing Stimuli	**ENV>NAV** Ab01.9 Auditory Detection Ab01.10 Auditory Discrimination	*nsd*

			Ab01.13 Olfactory Discrimination	

Notes: *nsd*=no significant differences

With respect to needing an ability at the time of hire, there were no statistical differences by SSC type. As noted in the overall discussion of abilities, all 31 of the physical, sensory, and psychomotor abilities were rated by 70% or more of the job analysis participants as needed at the time of hire.

By multi-specialty SSC types.

Additionally, the researchers examined importance ratings and whether an ability was needed at the time of hire by multi-specialty SSC type (e.g., with and without an ENV component). There were no statistical differences between the two multi-specialty types in the proportion of respondents who rated an any ability as More and Extremely Important (see Appendix G for detailed statistics), in the in mean ratings of importance of the 31 abilities by multi-specialty type, nor the proportion who marked an ability as required at the time of hire.

Abilities Summary.

Overall, there were only small differences in the importance of four out of 31 physical, sensory, and psychomotor abilities required to perform ATSS work at SSCs. Specialists assigned to Communications (COMM) SSCs rated two abilities related to hearing – Auditory Attention and Auditory Discrimination – as more important to the job than specialists assigned to Navigation (NAV) and Surveillance (SURV) SSCs. Not unexpectedly, specialists at Environmental (ENV) SSCs rated Dynamic Strength and Stamina as more important than specialists at Automation (AUTO) SSCs. All 31 physical abilities were rated by a majority of job analysis survey participants as required at the time of hire – and there were no differences by SSC type. There were no statistical differences on any metric by multi-specialty type.

Discussion

Overall summary.

The research objectives of this study were to document the range of physical requirements of ATSS work and to determine the degree to which those requirements vary across specialties. Both the differences in the demand for physical abilities by specialty in terms of other work activities and differences in the physical abilities required to perform maintenance tasks were examined.

In the first analysis, overall, the results indicate that at least monthly, the predominate work activities inherent to the daily tasks of an ATSS involved either crouching, stooping, or kneeling to reach equipment, lifting anything weighing 50 pounds or less, or carrying anything weighing less than 50 pounds. On the other hand, ATSSs were less frequently engaged in other work activities involving climbing near-vertical 30 foot or taller ladders to reach equipment, working in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask, or standing in a bucket lift to reach equipment. The ATSS job is characterized by a moderate physical demand as reflected in the frequency with which the physically-oriented other work activities were performed.

However, there were significant differences by SSC type in terms of how often the physically-oriented OWAs were performed. More of the physically-oriented other work activities were performed more frequently by specialists assigned to Environmental (ENV) or Multiple-Specialty SSCs with an ENV component than specialists at other SSC types while specialists at Automation) SSCs performed fewer of the physically-oriented OWAs than those at other SSC types. The physical demands on specialists at COMM, NAV, SURV, and Multiple-Specialty SSCs without an ENV varied and fell between the two extremes.

The second analysis focused on the abilities required to perform the ATSS job. Overall, nine out of 31 abilities were rated as "Important" or "Very Important" by 50% or more of job analysis survey participants. Four of the nine were related to vision: Color Detection; Color Discrimination; Near Vision; and Depth Perception. Four of the nine abilities with 50% or more endorsement rate related to manual dexterity: Finger Dexterity; Manual Dexterity; Precise Use of Controls; and Arm-Hand Steadiness. The other ability rated as "Important" or "Very Important" to successful job performance was Response to Competing Stimuli. The other 22 physical, sensory, and psychomotor abilities were rated as Important or Very Important by less than 50% of respondents.

Turning to differences by SSC type, there were only small differences in the importance of four out of 31 physical, sensory, and psychomotor abilities required to perform ATSS work at SSCs. Specialists assigned to Communications (COMM) SSCs rated two abilities related to hearing – Auditory Attention and Auditory Discrimination – as more important to the job than specialists assigned to Navigation (NAV) and Surveillance (SURV) SSCs. Not unexpectedly, specialists at Environmental (ENV) SSCs rated Dynamic Strength and Stamina as more important than specialists at Automation (AUTO) SSCs. All 31 physical abilities were rated by a majority of survey participants as required at the time of hire and there were no differences by SSC type. There were no differences in ratings of importance or need at entry on duty by multi-specialty type.

Limitations.

As in a previous study (Broach, et al., 2018), there were certain limitations. First, the degree to which participants were representative of the total population of field ATSSs might be challenged. It appeared that persons from Environmental and Multi-Specialty SSCs were slightly

over-represented. Second, the statistical power available for analyses by single-specialty SSCs was low due to small numbers of respondents at those types of SSCs. Therefore, false negatives (e.g., failure to find differences that in fact exist) are a possibility for those comparison in which "no significant differences" are reported. Next, no gender or race data were collected from respondents. It is unknown, therefore, whether the respondent demographics correspond to those of the population of field ATSSs. It is possible, therefore, that the participants are not completely representative of the population of ATSSs assigned to SSCs. Finally, survey frequency ratings indicating that an incidental activity was performed quarterly, semi-annually, or annually were excluded from the analyses which might have produced different results.

Conclusions.

The ATSS job is characterized by moderate physical demands in the course of performing maintenance tasks. Relatively speaking, specialists in the Environmental specialty perform some physically-oriented other work activities such as crouching, working outside, climbing short (less than 8-foot) ladders, and working with arms overhead, more often than specialists at other SSC types. Automation is the least physically demanding specialty. The other specialties fall in between these two poles. Performing these other work activities requires specialists to possess abilities such as sight, hearing, and strength at the time of hire. There were no differences by SSC type in the importance of 27 of 31 physical, sensory, and psychomotor abilities, however, all 31 of the physical, sensory, and psychomotor abilities were rated by 70% or more of the job analysis participants as needed at the time of hire. The overall conclusions are that the physical, sensory, and psychomotor abilities required are consistent across SSC types, specialty-specific physical, psychomotor, sensory ability profiles are not required. However, the statistical differences in performing physically-oriented other work activities are in the frequency or importance, not in the types physical, sensory, and psychomotor abilities required.

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Appendix A: Responsibilities and Requirements of the ATSS Position

ATSSs must be able to efficiently perform the essential functions of the position without hazard to themselves or others. Due to the nature of the job, usable vision (including color vision and near vision), hearing, and speech may be required. ATSSs may be required to lift and/or carry objects weighing up to 50 pounds; climb stairs/ladders up to 100 feet; be able to bend or stoop for extended periods; work in diverse environmental conditions (outside/extreme weather); work rotating shifts, weekends and/or holidays; and possibly travel away from home up to 80% of the time. *{Note: Newly hired A TSSs may spend a significant amount of time attending formal training at the FAA Academy in Oklahoma City, OK)* (JAT 2101, 2017)

5 CFR 339.203 Physical Requirements

(a) An agency may establish physical requirements for individual positions without OPM approval when such requirements are considered essential for performance of the duties of a specific position. Physical requirements must be clearly supported by the actual duties of the position, documented in the position description, and supported by a study(ies) or evaluation(s) establishing physical requirement(s) is job-related to the occupation(s).

(b) An applicant or employee may not be disqualified arbitrarily on the basis of physical requirements or other criteria that do not relate specifically to performance of the duties of a specific position.

https://www.law.cornell.edu/cfr/text/5/339.203

OPM Classification Guide

a. *Medical/Physical* -- The basis on which agencies may establish specific medical standards or physical requirements is discussed in 5 CFR 339. In general, there must be a direct relationship between the medical standard or physical requirement and the actual duties of the position being filled. Failure to meet an established medical standard or physical requirement means that the individual is not qualified for the position *unless* there is sufficient evidence that he or she can perform the duties of the position safely and efficiently despite a condition that would normally be disqualifying. Agencies must provide reasonable accommodation to qualified individuals with disabilities in accordance with Equal Employment Opportunity Commission regulations.

   Positions with sedentary, light, or moderately active duties are covered by the following medical standard:

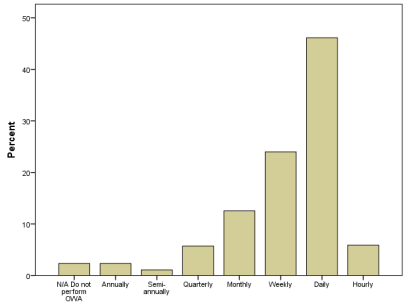
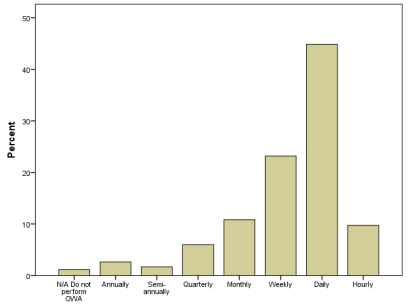
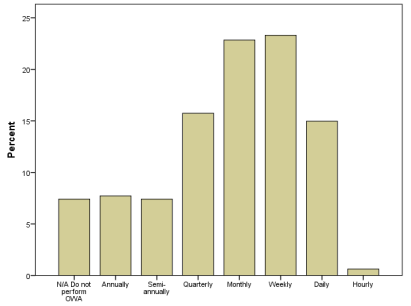
   Applicants must be physically and mentally able to perform efficiently the essential functions of the position, with or without reasonable accommodation, without hazard to themselves or others. Depending on the essential duties of a specific position, usable

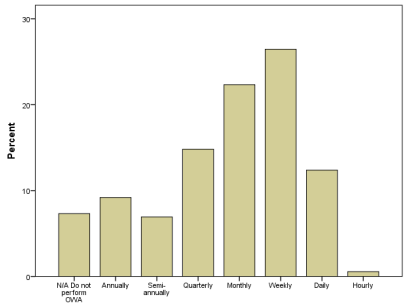
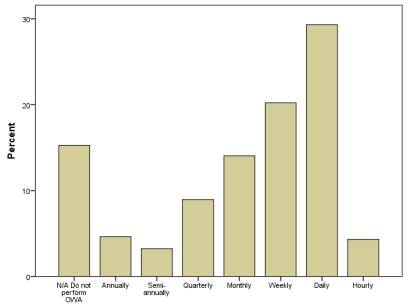
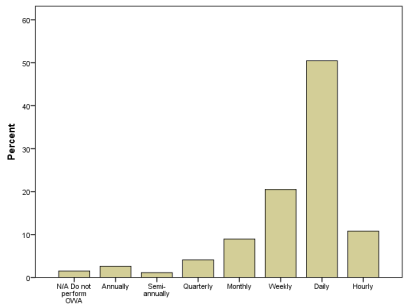
vision, color vision, hearing, or speech may be required. However, in most cases, a specific physical condition or impairment will not automatically disqualify an applicant for appointment. The loss or impairment of a specific function may be compensated for by the satisfactory use of a prosthesis or mechanical aid. Reasonable accommodation, in accordance with title 29 CFR 1613.704, must also be considered in determining an applicant's ability to perform the duties. Also, all positions involving Federal motor vehicle operation carry the additional medical requirements specified in *(f)* below.

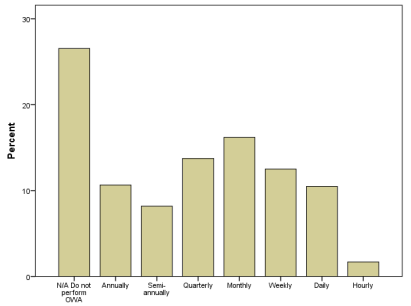
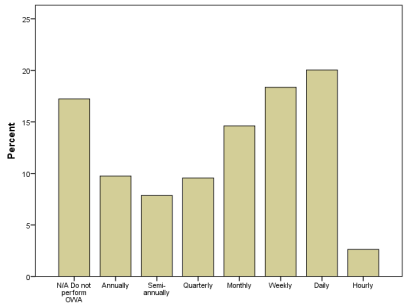
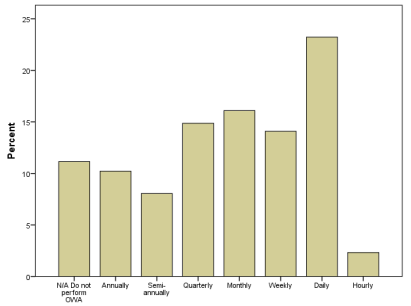
Positions with specific medical requirements and that involve arduous/hazardous duties or require a high standard of human reliability are identified in the Medical Requirements section. For such positions, the medical requirements are based on the arduous or hazardous nature of the duties typically performed in most of the positions covered. However, since individual positions may not include all such duties, a physical condition or impairment may be disqualifying for employment only if there is a direct relationship between the condition and the nature of the duties of the specific position to be filled. In some instances, a physical impairment will not disqualify an applicant for appointment if the condition is compensated for by a satisfactory prosthesis, mechanical aid, or by reason-able accommodation. Also, all positions involving Federal motor vehicle operation carry the additional medical requirements specified in *(f)* below.

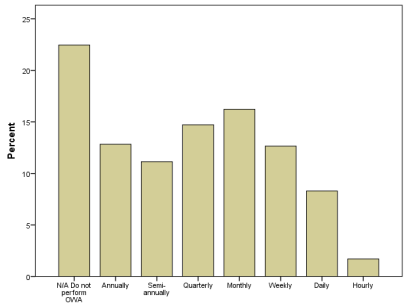
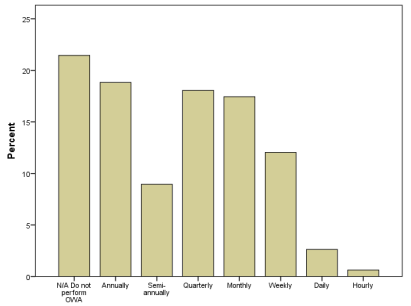
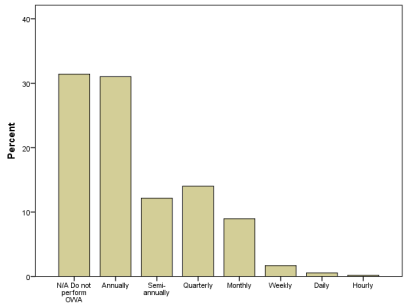
https://www.opm.gov/policy-data-oversight/classification-qualifications/general-schedule-qualification-policies/#url=desc

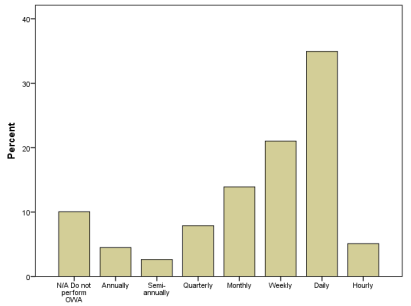
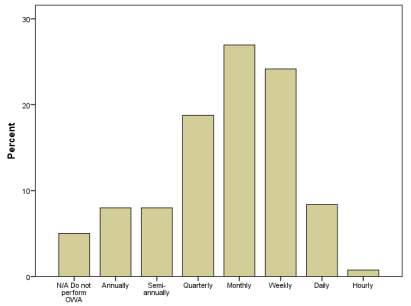
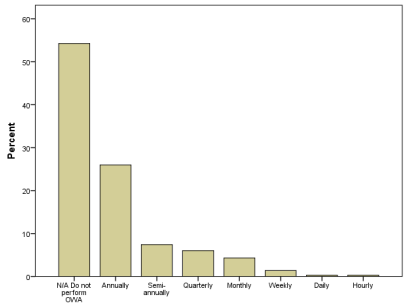
Appendix B: Overall ratings distribution and descriptive statistics of how frequently Other Work Activities (OWAs) performed

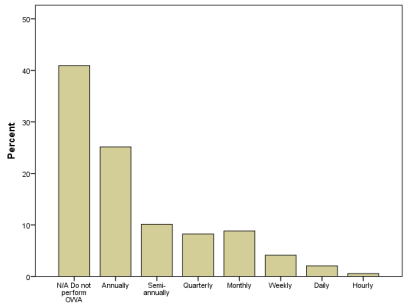
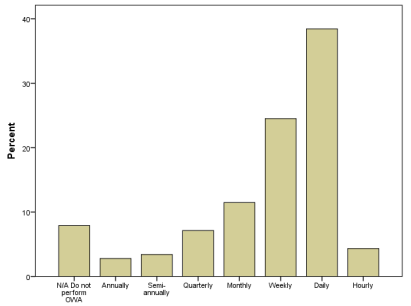
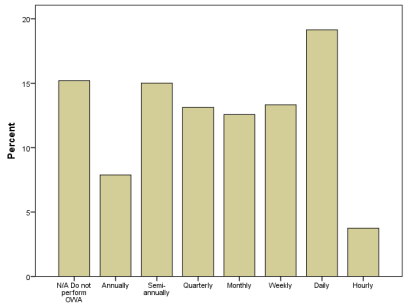
		Raw Ratings					Statistics[3]		
		N	% N/A	% Quarterly or less[1]	% Monthly or more[2]	Ratings Distribution	N	M	SD
OthAct.7	Lift anything weighing 50 pounds or less (including tools, tool bags, equipment, parts, etc.)?	646	2.3%	9.1%	88.5%		631	5.22	1.23
OthAct.8	Carry anything weighing less than 50 pounds?	535	1.1%	10.3%	88.6%		529	5.26	1.31
OthAct.9	Lift anything weighing more than 50 pounds (including tools, tool bags, equipment, parts, etc.)?	648	7.4%	30.9%	61.7%		600	4.02	1.48

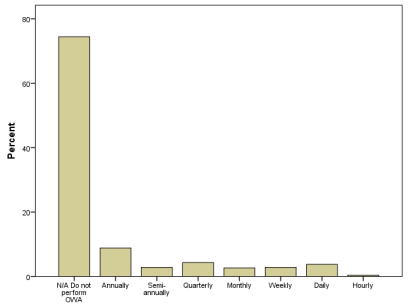
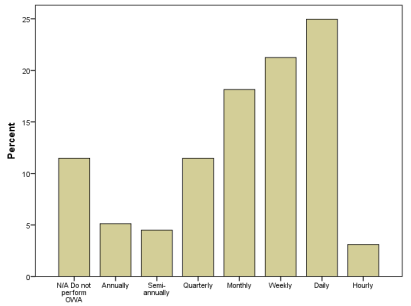
		Raw Ratings					Statistics[3]		
		N	% N/A	% Quarterly or less[1]	% Monthly or more[2]	Ratings Distribution	N	M	SD
OthAct.10	Carry anything weighing more than 50 pounds?	533	7.3%	31.0%	61.7%		494	3.96	1.49
OthAct.11	Walk across uneven, rough, or unfinished surfaces to reach equipment?	648	15.3%	16.8%	67.9%		549	4.74	1.51
OthAct.12	Crouch, stoop, or kneel to reach equipment?	537	1.5%	7.8%	90.7%		529	5.42	1.25

		Raw Ratings					Statistics[3]		
		N	% N/A	% Quarterly or less[1]	% Monthly or more[2]	Ratings Distribution	N	M	SD
OthAct.13	Crawl or creep (around, under, through equipment or false floors) to reach equipment?	648	26.5%	32.6%	40.9%		476	3.68	1.67
OthAct.14	Work in cramped or tightly confined equipment spaces?	534	17.2%	27.2%	55.6%		442	4.14	1.74
OthAct.15	Bend, twist, and/or reach into and hold an unusual body position to reach and/or work on equipment?	646	11.1%	33.1%	55.7%		574	4.07	1.73

		Raw Ratings					Statistics[3]		
		N	% N/A	% Quarterly or less[1]	% Monthly or more[2]	Ratings Distribution	N	M	SD
OthAct.20	Work with raised arms, reaching overhead, for extended periods of time (20 minutes or more)?	530	22.5%	38.7%	38.9%		411	3.47	1.66
OthAct.1	Climb a near-vertical ladder less than 30 feet tall to reach equipment?	648	21.5%	45.8%	32.7%		509	3.07	1.53
OthAct.20	Climb a near-vertical 30 foot or taller ladder to reach equipment?	535	31.4%	57.2%	11.4%		367	2.13	1.26

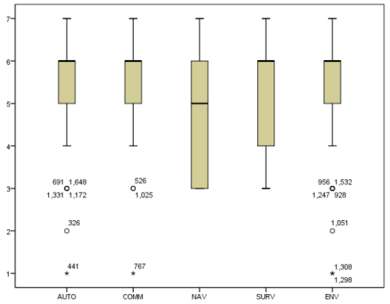
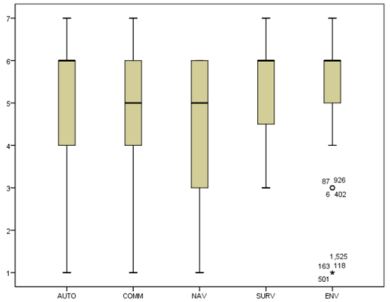
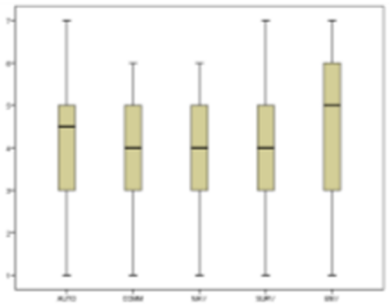
		Raw Ratings					Statistics[3]		
		N	% N/A	% Quarterly or less[1]	% Monthly or more[2]	Ratings Distribution	N	M	SD
OthAct.5	Climb stairs to reach equipment?	647	10.0%	15.0%	75.0%		582	4.88	1.47
OthAct.6	Use a portable ladder of less than 8 feet to reach equipment?	538	5.0%	34.8%	60.2%		511	3.84	1.40
OthAct.3	Stand in a bucket lift to reach equipment?	647	54.3%	39.4%	6.3%		296	1.91	1.28

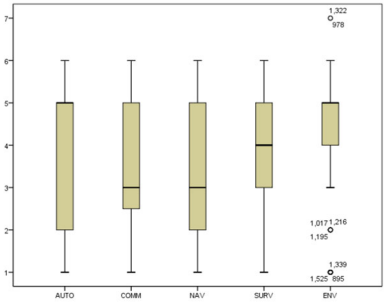
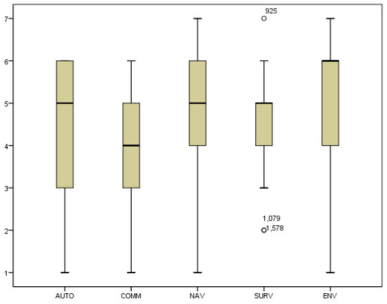
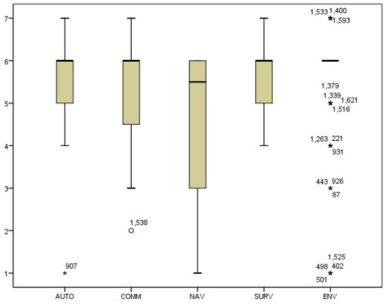
		Raw Ratings					Statistics[3]		
		N	% N/A	% Quarterly or less[1]	% Monthly or more[2]	Ratings Distribution	N	M	SD
OthAct.4	Stand on a movable, adjustable platform lift to reach equipment?	533	40.9%	43.5%	15.6%		315	2.41	1.56
OthAct.17	Work out of doors?	645	7.9%	13.3%	78.8%		594	5.00	1.36
OthAct.18	Work in extreme temperatures (heat or cold)?	533	15.2%	36.0%	48.8%		452	3.95	1.78

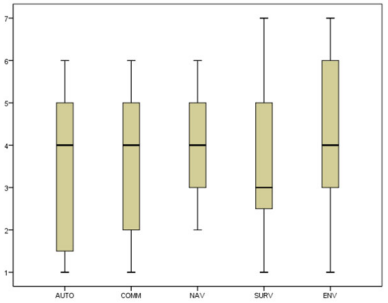
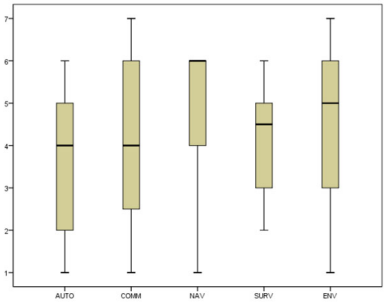
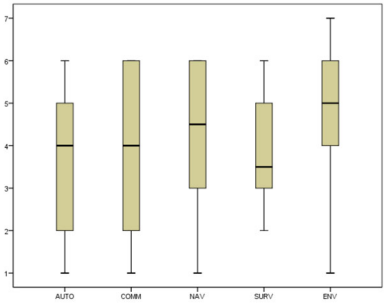
		Raw Ratings					Statistics[3]		
		N	% N/A	% Quarterly or less[1]	% Monthly or more[2]	Ratings Distribution	N	M	SD
OthAct.16	Work in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask?	532	74.4%	16.0%	9.6%		136	3.02	1.90
OthAct.19	Work in poorly illuminated spaces requiring use of supplemental task lighting?	645	11.5%	21.1%	67.4%		571	4.50	1.51

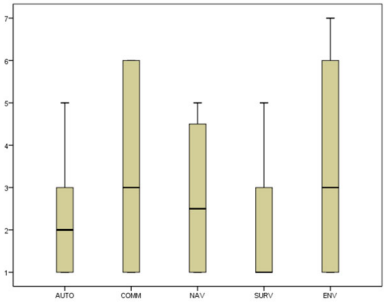
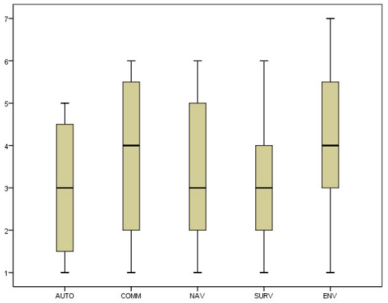
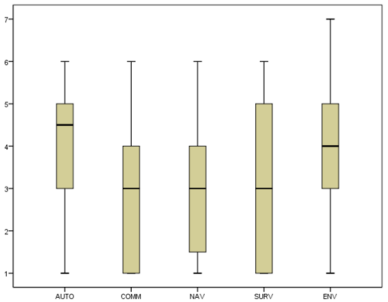
Notes: [1]Quarterly or less = rating of 1 (Annually), 2 (Semi-annually), or 3 (Quarterly)
[2]Monthly or more = rating of 4 (Monthly), 5 (Weekly), 6 (Daily), or 7 (Hourly)
[3]Statistics are computed only for those respondents indicating the other work activity was performed (rating of 1 through 7)

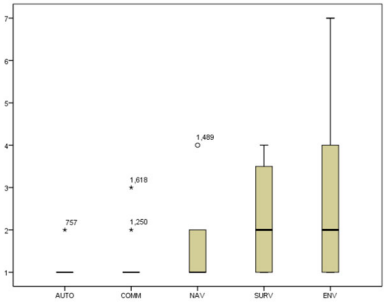
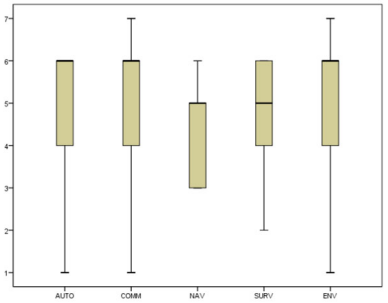
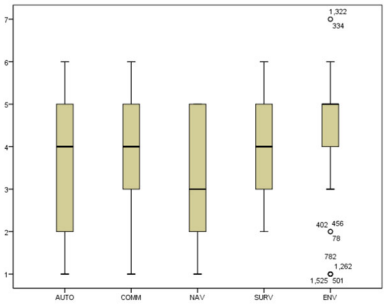
Appendix C: Frequency rating (for those performing the other work activity) descriptive statistics and overall F-test by single-specialty SSC type

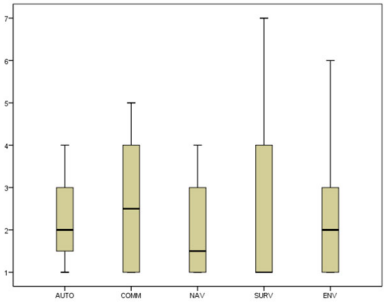
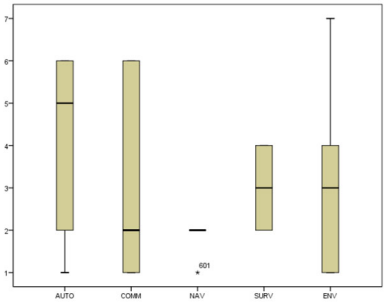
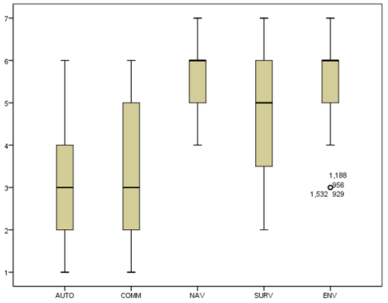
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.7	Lift anything weighing 50 pounds or less	AUTO	49	5.20	1.207		*F*(4, 245)=0.87, *ns*
		COMM	37	5.24	1.164		
		NAV	18	4.89	1.451		
		SURV	18	5.33	1.138		
		ENV	128	5.41	1.193		
OthAct.8	Carry anything weighing less than 50 pounds?	AUTO	27	4.93	1.662		*F*(4, 187)=2.22, *ns*
		COMM	31	4.94	1.482		
		NAV	10	4.40	1.838		
		SURV	19	5.37	1.342		
		ENV	105	5.47	1.331		
OthAct.9	Lift anything weighing 50 pounds or more (including tools, tool bags, equipment, parts, etc.)?	AUTO	42	4.17	1.545		*F*(2, 228)=1.58, *ns*
		COMM	33	3.61	1.478		
		NAV	17	4.18	1.510		
		SURV	18	4.00	1.534		
		ENV	123	4.35	1.558		

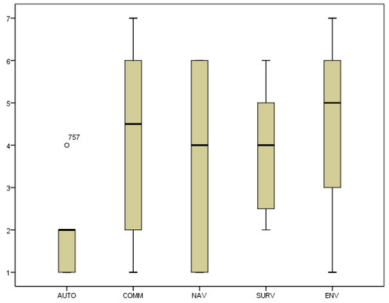
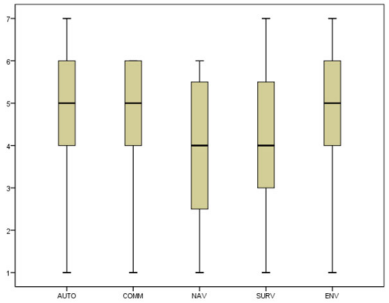
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.10	Carry anything weighing more than 50 pounds?	AUTO	26	4.00	1.766		*F*(4, 172)=1.65, *ns*
		COMM	20	3.40	1.698		
		NAV	10	3.20	1.751		
		SURV	17	4.06	1.249		
		ENV	104	4.19	1.626		
OthAct.11	Walk across uneven, rough, or unfinished surfaces to reach equipment?	AUTO	21	4.43	1.777		*F*(4, 195)=4.79***
		COMM	27	3.74	1.723		
		NAV	16	4.69	1.537		
		SURV	13	4.54	1.506		
		ENV	123	5.11	1.483		
OthAct.12	Crouch, stoop, or kneel to reach equipment?	AUTO	26	5.50	1.208		*F*(4, 184)=2.18, *ns*
		COMM	31	5.29	1.189		
		NAV	10	4.30	2.111		
		SURV	17	5.47	0.874		
		ENV	105	5.60	1.438		

ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.13	Crawl or creep (around, under, through equipment or false floors) to reach equipment?	AUTO COMM NAV SURV ENV	32 25 10 15 109	3.50 3.52 3.90 3.47 4.28	1.884 1.759 1.197 1.846 1.704		*F*(4, 186)=2.18, *ns*
OthAct.14	Work in cramped or tightly confined equipment spaces?	AUTO COMM NAV SURV ENV	23 23 7 14 99	3.74 4.04 4.71 4.14 4.48	1.888 1.942 1.976 1.460 1.705		*F*(4, 161)=1.11, *ns*
OthAct.15	Bend, twist, and/or reach into and hold an unusual body position to reach and/or work on equipment?	AUTO COMM NAV SURV ENV	38 35 14 16 122	3.74 3.77 4.43 3.81 4.75	1.766 1.957 1.555 1.424 1.607		*F*(4, 220)=4.49**

ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.16	Work in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask?	AUTO	5	2.40	1.673		*F*(4, 58)=0.45, *ns*
		COMM	5	3.40	2.510		
		NAV	4	2.75	2.062		
		SURV	3	2.33	2.309		
		ENV	46	3.41	2.166		
OthAct.20	Work with raised arms, reaching overhead, for extended periods of time (20 minutes or more)?	AUTO	27	1.33	1.861		*F*(4, 139)=1.86, *ns*
		COMM	31	1.87	2.277		
		NAV	10	3.30	1.947		
		SURV	20	2.15	1.981		
		ENV	106	3.51	2.144		
		Climb					
OthAct.1	Climb a near-vertical ladder less than 30 feet tall to reach equipment?	AUTO	49	1.12	1.996		*F*(4, 173)=2.37, *ns*
		COMM	40	1.83	1.824		
		NAV	18	2.56	1.756		
		SURV	18	2.50	2.036		
		ENV	130	2.95	1.942		

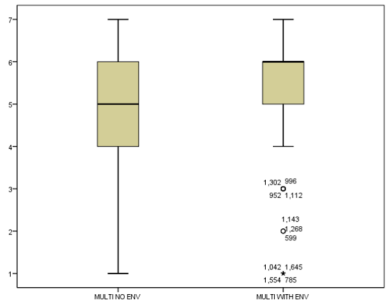
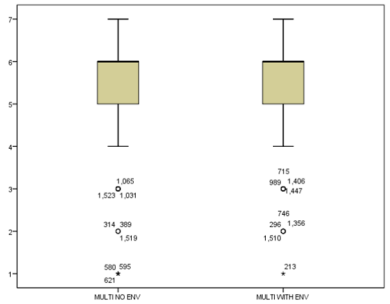
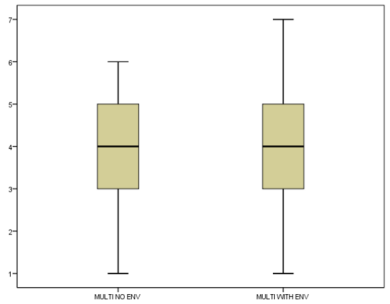
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.2	Climb a near-vertical 30 foot or taller ladder to reach equipment?	AUTO COMM NAV SURV ENV MULTI WITH ENV	27 31 10 20 107 194	0.22 0.45 1.50 1.25 1.77 1.59	0.506 0.723 1.080 1.517 1.708 1.386		*F*(4, 109)=2.64*
OthAct.5	Climb stairs to reach equipment?	AUTO COMM NAV SURV ENV	49 40 18 18 129	3.80 4.18 3.44 4.22 4.91	2.491 2.438 2.121 1.927 1.774		*F*(4, 222)=0.64, *ns*
OthAct.6	Use a portable ladder of less than 8 feet to reach equipment?	AUTO COMM NAV SURV ENV	27 33 10 20 107	3.56 3.12 2.90 3.10 4.31	1.928 1.980 1.853 1.971 1.424		*F*(4, 178)=2.21, *ns*

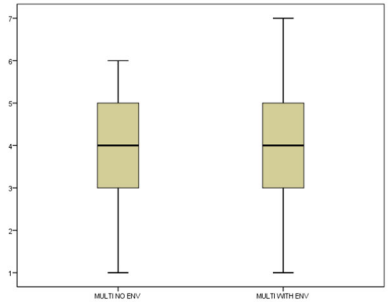
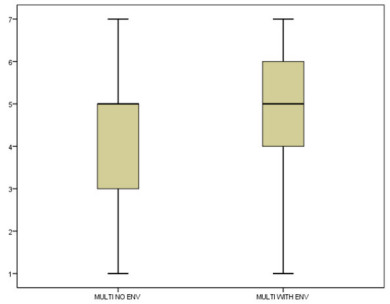
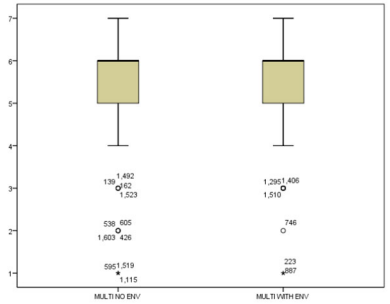
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.3	Stand in a bucket lift to reach equipment?	AUTO	49	0.14	0.645		*F*(4, 111)=0.22, *ns*
		COMM	40	0.53	1.261		
		NAV	18	1.17	1.425		
		SURV	18	0.56	1.653		
		ENV	130	1.55	1.505		
OthAct.4	Stand on a movable, adjustable platform lift to reach equipment?	AUTO	27	1.30	2.216		*F*(4, 109)=1,68, *ns*
		COMM	31	1.00	1.949		
		NAV	10	1.50	0.850		
		SURV	20	0.75	1.410		
		ENV	106	2.08	1.852		
		Adverse Environmental Conditions					
OthAct.17	Work out of doors?	AUTO	14	3.14	1.748		*F*(4, 204)=28.24***
		COMM	35	3.34	1.814		
		NAV	16	5.63	0.957		
		SURV	16	4.69	1.702		
		ENV	128	5.50	0.980		

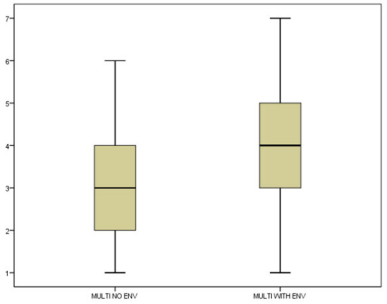
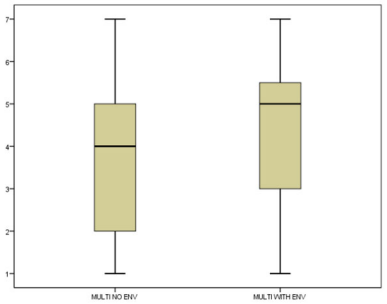
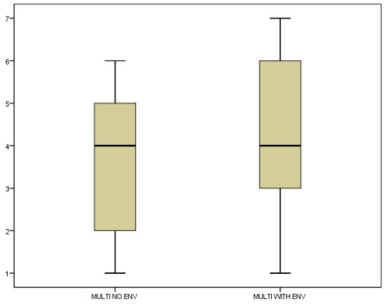
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.18	Work in extreme temperatures (heat or cold)?	AUTO	7	1.86	1.069		*F*(4, 138)=4.86***
		COMM	14	3.93	2.200		
		NAV	10	3.70	2.312		
		SURV	15	3.80	1.521		
		ENV	97	4.70	1.832		
OthAct.19	Work in poorly illuminated spaces requiring use of supplemental task lighting?	AUTO	42	4.88	1.517		*F*(4, 219)=2.16, *ns*
		COMM	32	4.56	1.605		
		NAV	15	3.93	1.831		
		SURV	15	4.07	1.907		
		ENV	120	4.88	1.435		

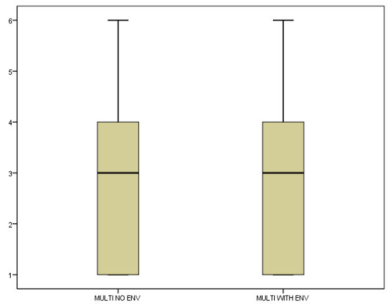
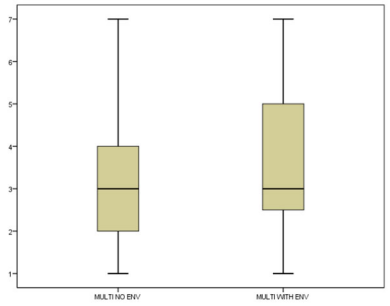
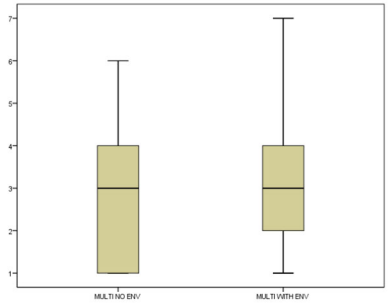
Notes: 1Frequency rating scale 1=Annually, 2=Semi-annually, 3=Quarterly, 4=Monthly, 5=Weekly, 6=Daily, 7=Hourly

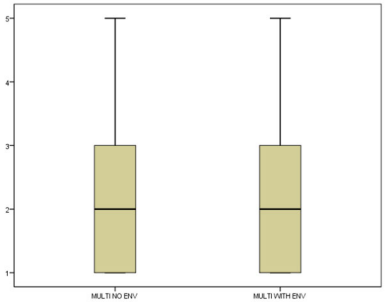
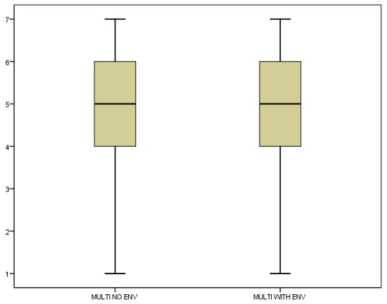
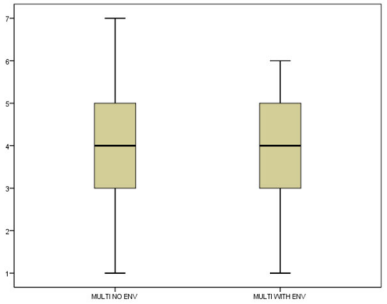
Appendix D: Descriptive statistics for frequency rating (for those performing the other work activity) and overall F-test by multi-specialty SSC type

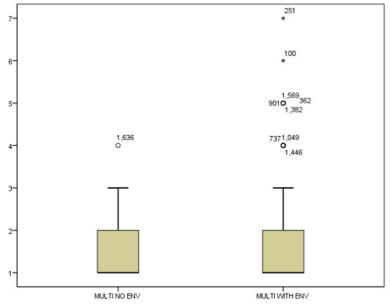
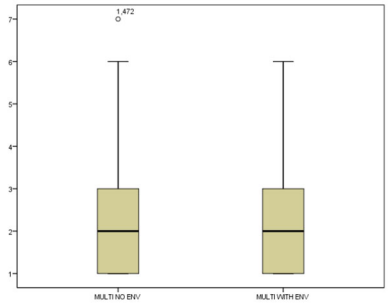
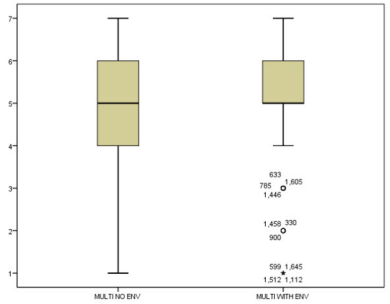
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.7	Lift anything weighing 50 pounds or less	MULTI–ENV MULTI+ENV	122 259	5.02 5.24	1.373 1.172		F(1, 379)=2.59, ns
OthAct.8	Carry anything weighing less than 50 pounds?	MULTI–ENV MULTI+ENV	146 191	5.21 5.32	1.314 1.142		F(1, 335)=0.70, ns
OthAct.9	Lift anything weighing 50 pounds or more (including tools, tool bags, equipment, parts, etc.)?	MULTI–ENV MULTI+ENV	115 252	3.62 4.05	1.508 1.383		F(1, 365)=7.35**

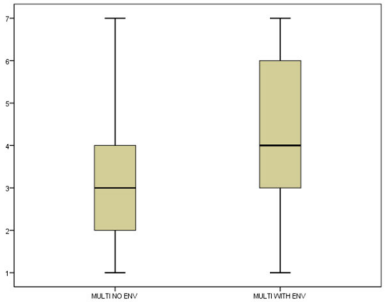
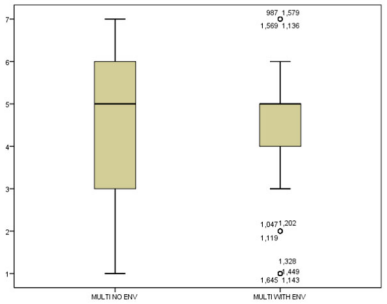
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.10	Carry anything weighing more than 50 pounds?	MULTI–ENV MULTI+ENV	133 184	3.86 3.99	1.418 1.397		F(1, 315)=0.66, ns
OthAct.11	Walk across uneven, rough, or unfinished surfaces to reach equipment?	MULTI–ENV MULTI+ENV	111 238	4.32 4.89	1.495 1.403		F(1, 347)=12.39***
OthAct.12	Crouch, stoop, or kneel to reach equipment?	MULTI–ENV MULTI+ENV	146 194	5.31 5.46	1.229 1.116		F(1, 338)=1.49, ns

ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.13	Crawl or creep (around, under, through equipment or false floors) to reach equipment?	MULTI–ENV MULTI+ENV	86 199	3.16 3.63	1.600 1.564		F(1, 283)=5.36*
OthAct.14	Work in cramped or tightly confined equipment spaces?	MULTI–ENV MULTI+ENV	117 159	3.84 4.20	1.766 1.672		F(1, 274)=3.04, ns
OthAct.15	Bend, twist, and/or reach into and hold an unusual body position to reach and/or work on equipment?	MULTI–ENV MULTI+ENV	109 240	3.60 4.02	1.673 1.720		F(1, 347)=4.64*

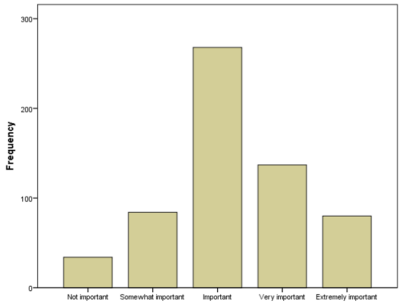
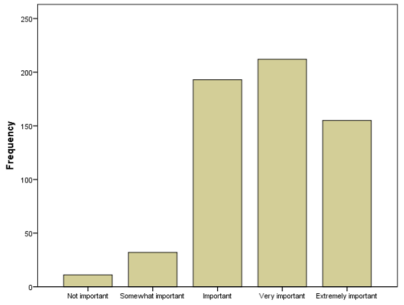
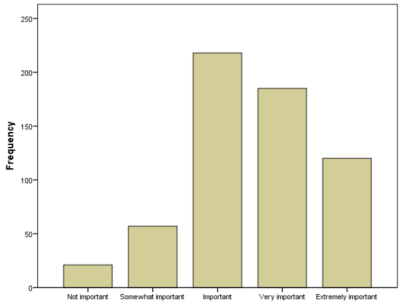
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.16	Work in poorly ventilated spaces requiring personal protective equipment such as a positive-pressure respirator/mask?	MULTI–ENV MULTI+ENV	23 50	2.87 2.82	1.714 1.687		F(1, 71)=0.01, ns
OthAct.20	Work with raised arms, reaching overhead, for extended periods of time (20 minutes or more)?	MULTI–ENV MULTI+ENV	108 159	2.99 3.53	1.649 1.479		F1, 265)=7.74**
OthAct.1	Climb a near-vertical ladder less than 30 feet tall to reach equipment?	MULTI–ENV MULTI+ENV	106 225	2.64 3.02	1.475 1.451		F(1, 329)=4.79*

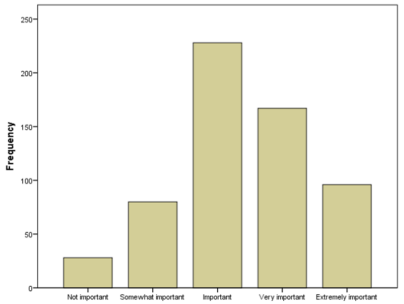
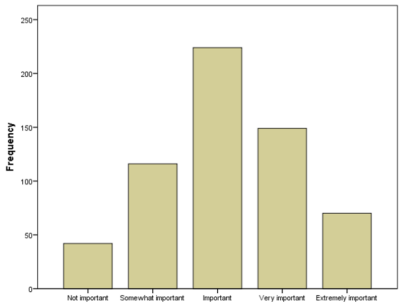
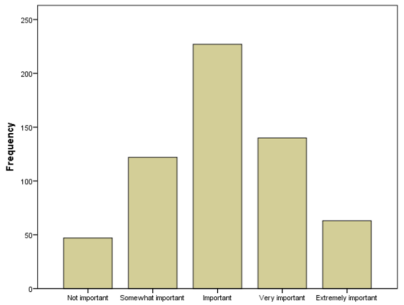
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.2	Climb a near-vertical 30 foot or taller ladder to reach equipment?	MULTI–ENV MULTI+ENV	107 146	2.10 2.12	1.124 1.201		F(1, 251)=0.01, ns
OthAct.5	Climb stairs to reach equipment?	MULTI–ENV MULTI+ENV	116 239	4.72 4.90	1.431 1.406		F(1, 353)=1.38, ns
OthAct.6	Use a portable ladder of less than 8 feet to reach equipment?	MULTI–ENV MULTI+ENV	139 189	3.53 3.80	1.451 1.241		F(1, 326)=3.50, ns

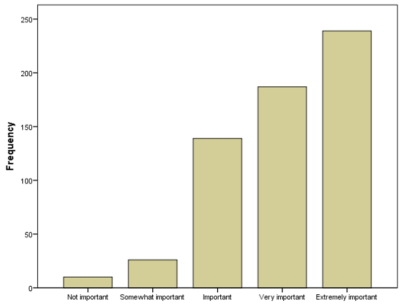
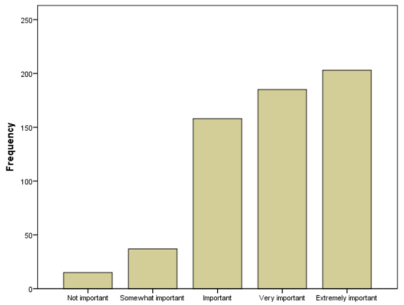
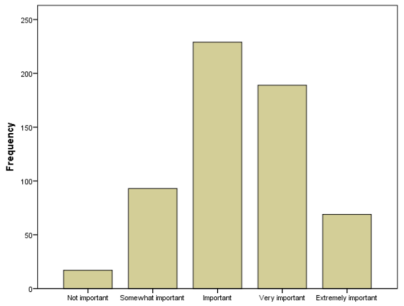
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.3	Stand in a bucket lift to reach equipment?	MULTI–ENV MULTI+ENV	42 138	1.45 1.76	0.772 1.224		F(1, 178)+2.38, ns
OthAct.4	Stand on a movable, adjustable platform lift to reach equipment?	MULTI–ENV MULTI+ENV	81 120	2.27 2.15	1.533 1.339		F(1, 199)=0.35, ns
OthAct.17	Work out of doors?	MULTI–ENV MULTI+ENV	124 261	4.70 5.20	1.331 1.160		F(1, 383)=14.05***

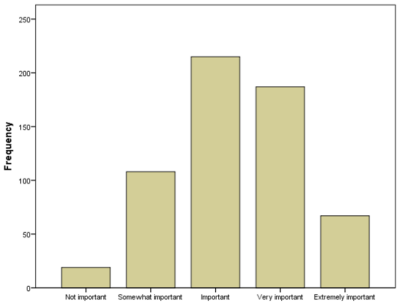
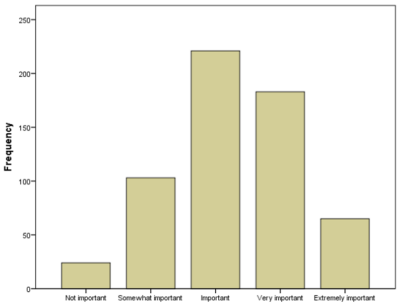
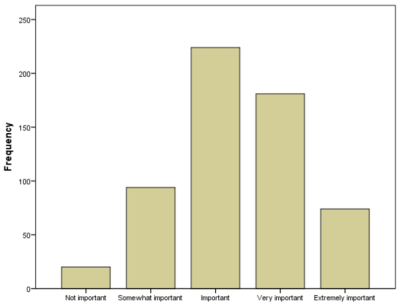
ID	Description	Specialty	N	M	SD	Boxplot for Frequency of Performing OWA by SSC type[1]	Overall F-test
OthAct.18	Work in extreme temperatures (heat or cold)?	MULTI–ENV MULTI+ENV	133 176	3.37 4.10	1.569 1.679		F(1, 307)=15.07***
OthAct.19	Work in poorly illuminated spaces requiring use of supplemental task lighting?	MULTI–ENV MULTI+ENV	113 234	4.38 4.36	1.520 1.450		F(1, 345)=0.01, ns

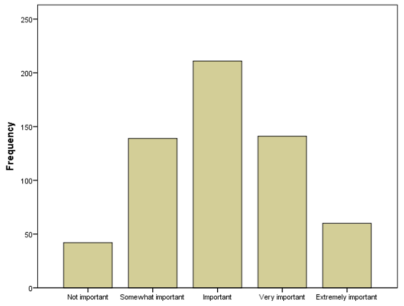
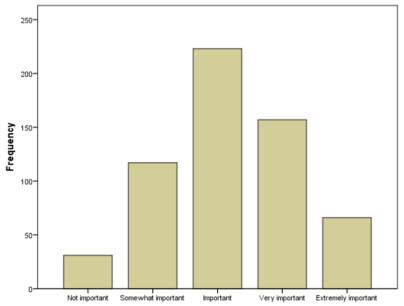
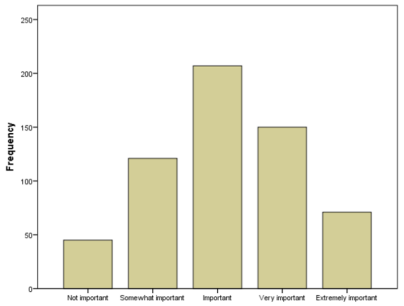
Appendix E: Descriptive statistics overall for Ability importance

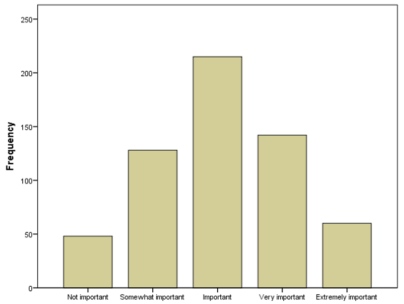
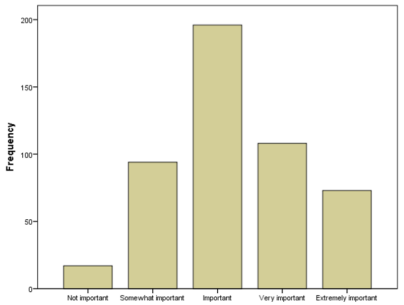
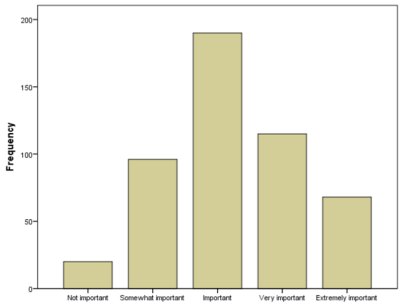
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb01.01	Far Vision	603	3.24	1.033	
ImpAb01.02	Near Vision	603	3.78	0.951	
ImpAb01.03	Depth Perception	601	3.54	1.024	

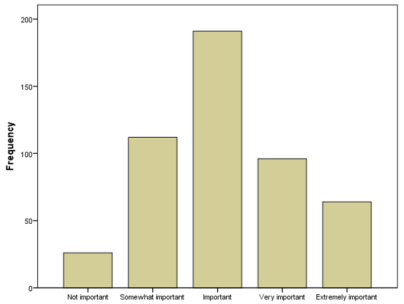
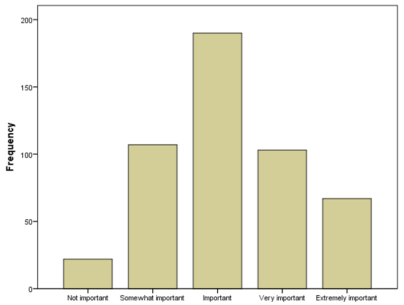
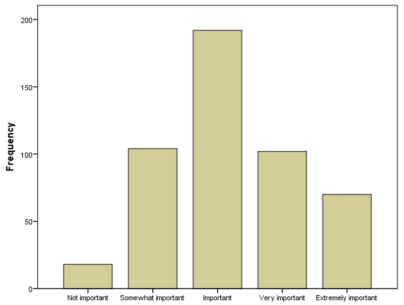
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb01.04	Peripheral Vision	599	3.37	1.051	
ImpAb01.05	Night Vision	601	3.15	1.080	
ImpAb01.06	Glare Tolerance	599	3.08	1.080	

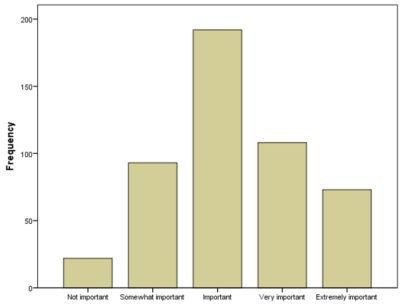
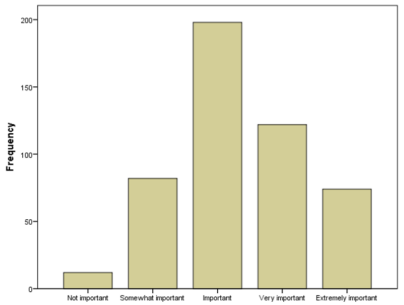
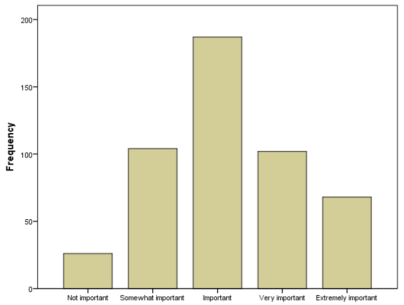
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb01.07	Color Detection	601	4.03	0.976	
ImpAb01.08	Color Discrimination	598	3.88	1.031	
ImpAb01.09	Auditory Detection	597	3.34	0.968	

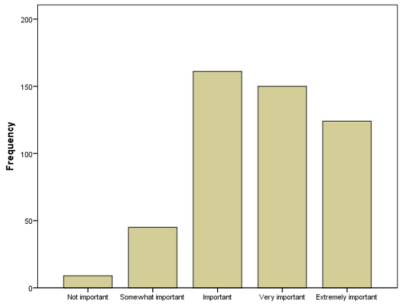
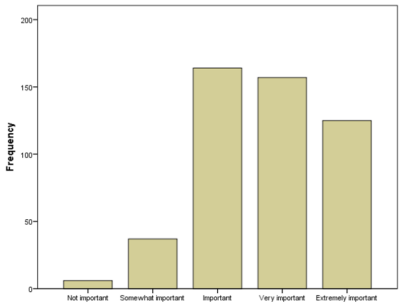
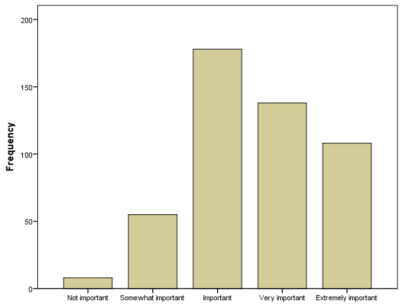
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb01.10	Auditory Discrimination	596	3.29	0.994	
ImpAb01.11	Auditory Attention	596	3.27	1.002	
ImpAb01.12	Sound Localization	593	3.33	0.996	

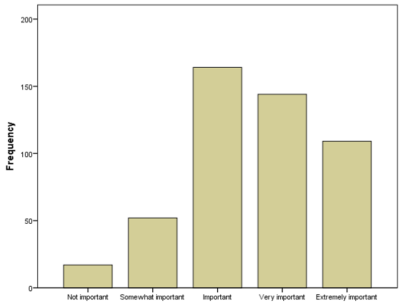
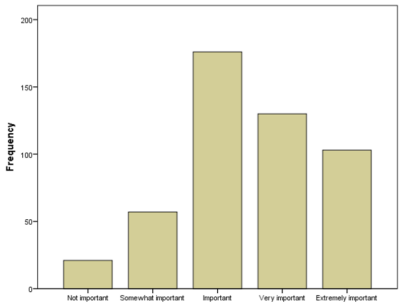
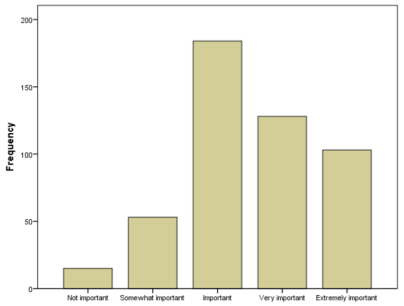
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb01.13	Olfactory Discrimination	593	3.06	1.076	
ImpAb01.14	Tactile Discrimination	594	3.19	1.040	
ImpAb01.15	Proprioception	594	3.14	1.105	

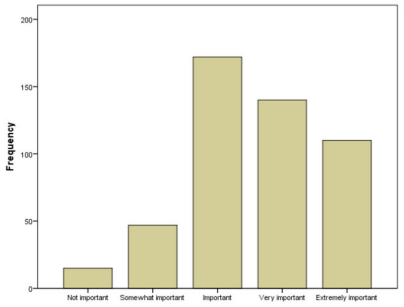
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb01.16	Haptic Identification	593	3.06	1.087	
ImpAb07.1	Trunk Strength	488	3.26	1.043	
ImpAb07.2	Static Strength	489	3.24	1.048	

ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb07.3	Dynamic Strength	489	3.12	1.072	
ImpAb07.4	Dynamic Flexibility	489	3.18	1.062	
ImpAb07.5	Extent Flexibility	486	3.21	1.052	

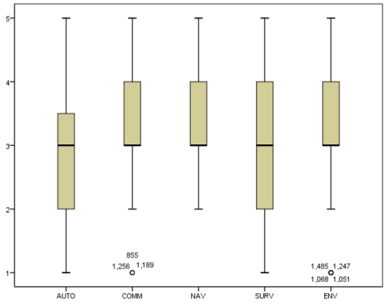
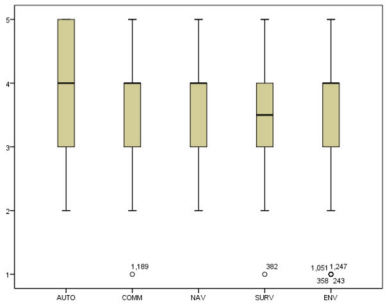
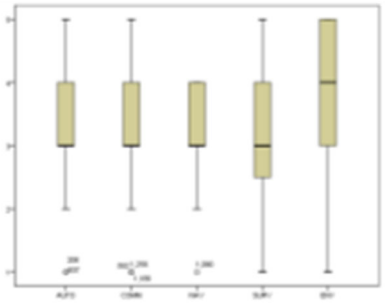
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb07.6	Dynamic Body Coordination	488	3.24	1.066	
ImpAb07.7	Gross Body Equilibrium	488	3.34	1.006	
ImpAb07.8	Stamina	487	3.17	1.081	

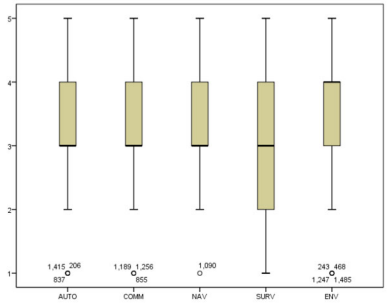
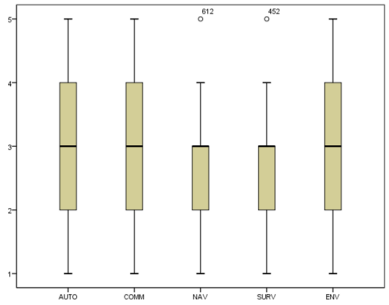
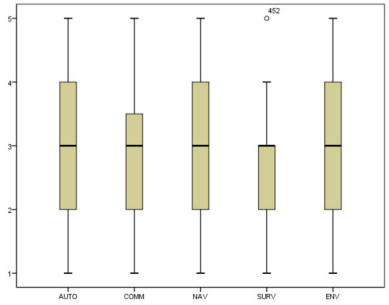
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb08.1	Manual Dexterity	489	3.69	1.010	
ImpAb08.2	Finger Dexterity	489	3.73	0.967	
ImpAb08.3	Arm-Hand Steadiness	487	3.58	1.007	

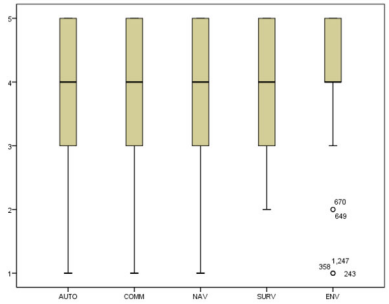
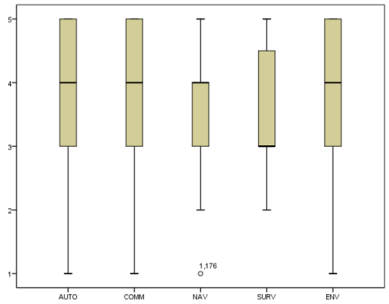
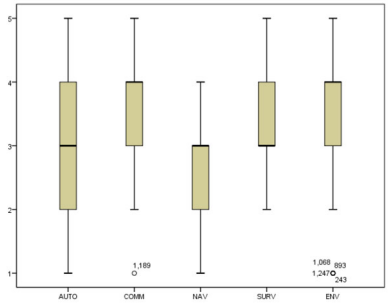
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb08.4	Precise Use of Controls	486	3.57	1.058	
ImpAb08.5	Multi-Limb Coordination	487	3.49	1.081	
ImpAb08.6	Sensory-Motor Coordination	483	3.52	1.041	

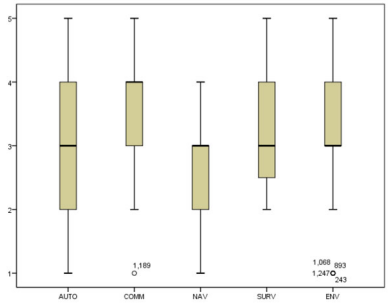
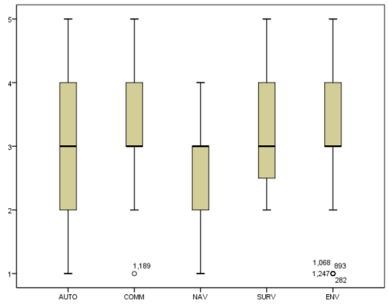
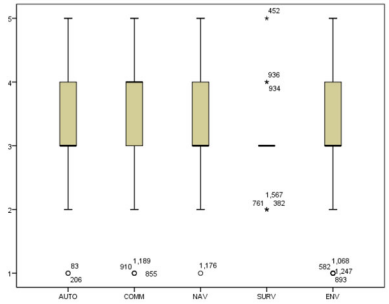
ID	Ability Description	*N*	*Mean*	*SD*	Ratings Distribution
ImpAb08.7	Response to Competing Stimuli	484	3.58	1.039	

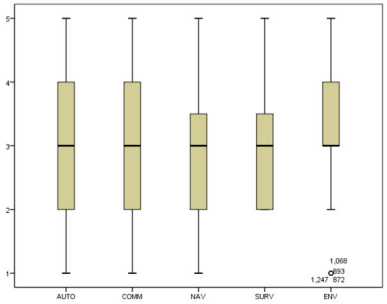
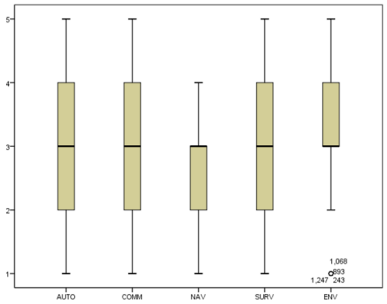
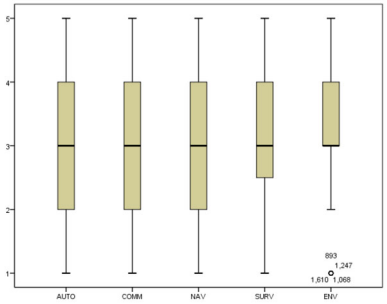
Appendix F: Descriptive statistics for and ANOVA of importance rating of Abilities to successful performance on the job by single-specialty SSC type

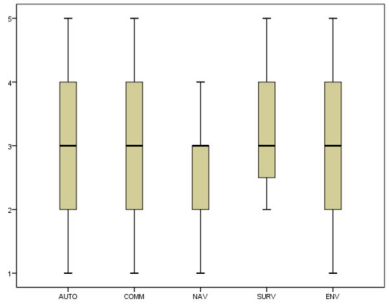
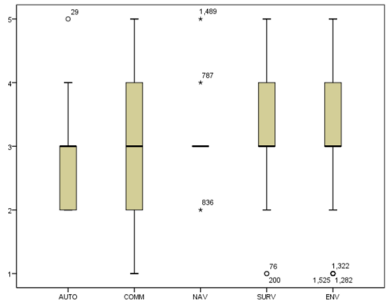
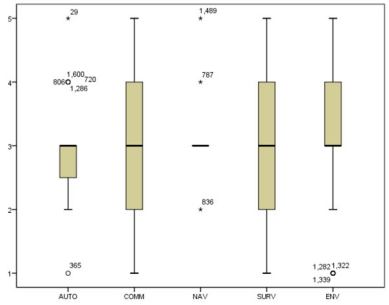
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab01.1	Far Vision	AUTO	45	2.89	1.092		F(4, 238)=2.62*
		COMM	34	3.03	1.029		
		NAV	15	3.20	0.862		
		SURV	15	3.00	1.254		
		ENV	122	3.43	1.036		
Ab01.2	Near Vision	AUTO	45	3.78	0.974		F(4, 237)=0.63, ns
		COMM	34	3.59	0.988		
		NAV	15	3.60	0.910		
		SURV	15	3.27	1.033		
		ENV	122	3.74	0.934		
Ab01.3	Depth Perception	AUTO	45	3.29	1.121		F(4, 236)=2.37, ns
		COMM	34	3.38	1.045		
		NAV	15	3.00	0.845		
		SURV	15	3.13	1.125		
		ENV	122	3.70	1.036		

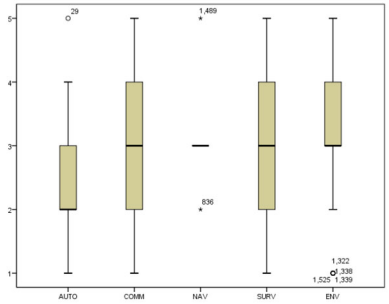
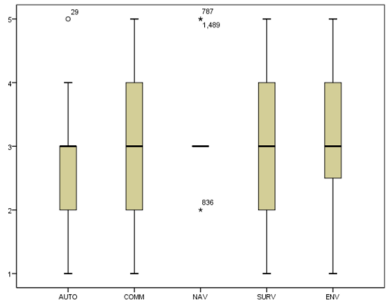
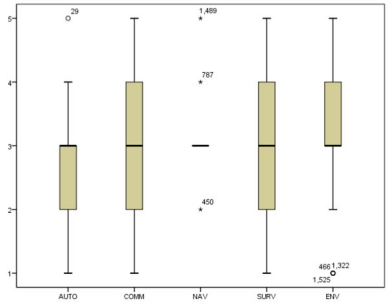
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab01.4	Peripheral Vision	AUTO	45	3,18	1.154		F(4, 236)=1.91, ns
		COMM	34	3.24	1.046		
		NAV	15	3.00	1.000		
		SURV	15	3.07	1.223		
		ENV	122	3.60	1.065		
Ab01.5	Night Vision	AUTO	45	3.22	1.312		F(2, 236)=1.41, ns
		COMM	34	3.06	1.013		
		NAV	15	2.73	1.100		
		SURV	15	2.67	1.175		
		ENV	122	3.31	1.143		
Ab01.6	Glare Tolerance	AUTO	45	2.71	1.359		F(4, 235)=2.56*
		COMM	34	2.85	1.019		
		NAV	15	2.73	1.223		
		SURV	15	2.67	1.175		
		ENV	122	3.30	1.111		

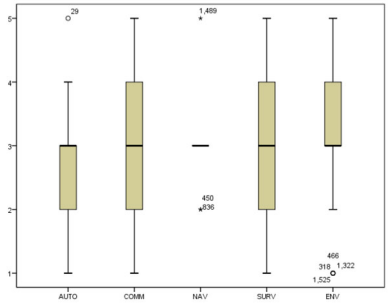
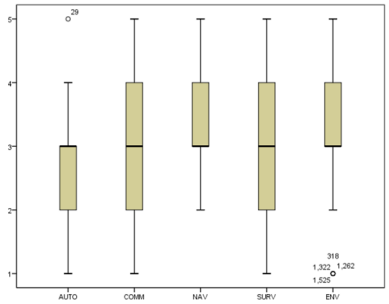
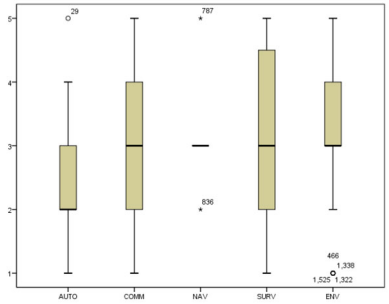
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab01.7	Color Detection	AUTO	45	3.80	1.140		F(4, 236)=1.37. ns
		COMM	34	3.71	1.060		
		NAV	15	3.73	1.335		
		SURV	15	3.80	1.014		
		ENV	122	4.10	0.876		
Ab01.8	Color Discrimination	AUTO	45	3.76	1.204		F(4, 235)=0.77, ns
		COMM	34	3.71	1.031		
		NAV	15	3.47	1.246		
		SURV	15	3.60	1.056		
		ENV	122	3.91	0.996		
Ab01.9	Auditory Detection	AUTO	45	3.00	1.087		F(4, 237)=3.80**
		COMM	34	3.62	0.922		
		NAV	15	2.73	0.799		
		SURV	15	3.27	0.961		
		ENV	122	3.43	1.036		

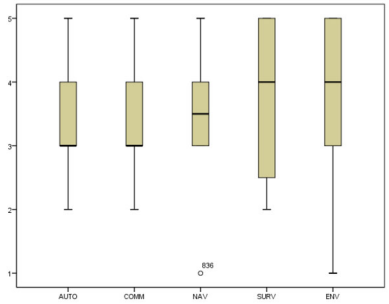
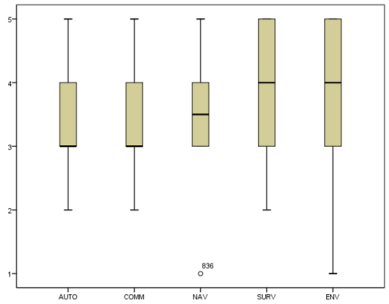
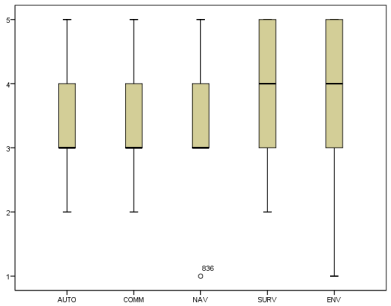
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab01.10	Auditory Discrimination	AUTO	45	3.04	1.086		F(4, 237)=3.20*
		COMM	34	3.59	0.995		
		NAV	15	2.67	0.724		
		SURV	15	3.13	0.915		
		ENV	122	3.37	1.077		
Ab01.11	Auditory Attention	AUTO	45	3.16	1.086		F(4, 236)=1.86, ns
		COMM	34	3.44	0.927		
		NAV	15	2.67	0.724		
		SURV	15	3.20	1.014		
		ENV	122	3.34	1.058		
Ab01.12	Sound Localization	AUTO	45	3.20	1.014		F(4, 236)=0.77, ns
		COMM	34	3.35	1.098		
		NAV	15	3.00	1.000		
		SURV	15	3.07	0.799		
		ENV	122	3.39	1.049		

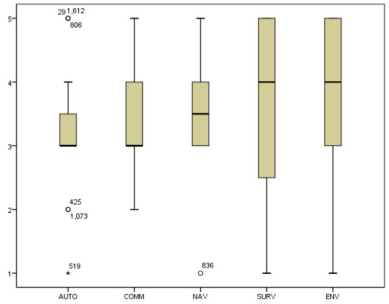
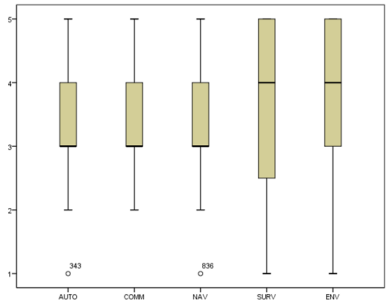
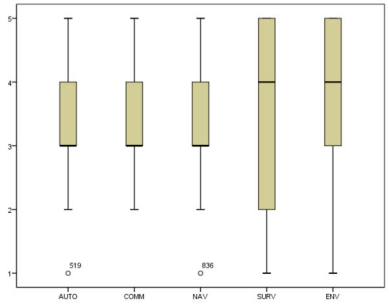
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab01.13	Olfactory Discrimination	AUTO	45	2.84	1.205		F(4, 236)=2.16, ns
		COMM	34	2.94	1.014		
		NAV	15	2.80	1.014		
		SURV	15	3.00	0.926		
		ENV	122	3.36	1.076		
Ab01.14	Tactile Discrimination	AUTO	45	2.96	1.101		F(4, 236)=2.61*
		COMM	34	2.88	1.066		
		NAV	15	2.60	0.910		
		SURV	15	2.93	1.100		
		ENV	122	3.38	1.078		
Ab01.15	Proprioception	AUTO	45	1.26	0.449		F(4, 235)=1.79, ns
		COMM	34	1.23	0.430		
		NAV	15	1.55	0.322		
		SURV	15	1.18	0.405		
		ENV	122	1.17	0.379		

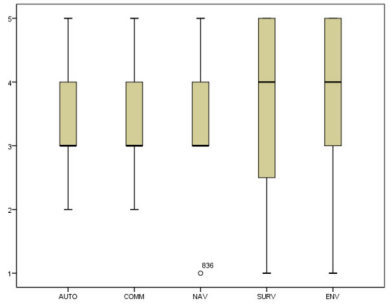
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab01.16	Haptic Identification	AUTO	45	2.99	1.234		F(4, 233)=2.37, ns
		COMM	34	2.82	1.167		
		NAV	15	2.33	0.900		
		SURV	15	3.13	0.915		
		ENV	122	3.25	1.110		
Ab07.1	Trunk Strength	AUTO	21	2.81	0.928		F(4, 167)=1.10, ns
		COMM	28	3.21	1.197		
		NAV	9	3.00	0.500		
		SURV	19	3.32	1.250		
		ENV	92	3.36	1.115		
Ab07.2	Static Strength	AUTO	21	2.95	0.921		F(4, 168)=0.61, ns
		COMM	28	3.14	1.145		
		NAV	9	3.00	0.500		
		SURV	19	3.16	1.344		
		ENV	92	3.33	1.101		

ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab07.3	Dynamic Strength	AUTO	21	2.43	1.028		F(4, 168)=2.15, ns
		COMM	28	3.14	1.177		
		NAV	9	2.89	0.333		
		SURV	19	3.11	1.329		
		ENV	92	3.25	1.145		
Ab07.4	Dynamic Flexibility	AUTO	21	2.67	0.966		F(4, 168)=1.15, ns
		COMM	28	3.11	1.166		
		NAV	9	3.11	0.782		
		SURV	19	3.11	1.329		
		ENV	92	3.24	1.123		
Ab07.5	Extent Flexibility	AUTO	21	2.67	0.966		F(4, 168)=1.31, ns
		COMM	28	3.11	1.166		
		NAV	9	3.00	0.500		
		SURV	19	3.21	1.273		
		ENV	92	3.27	1.100		

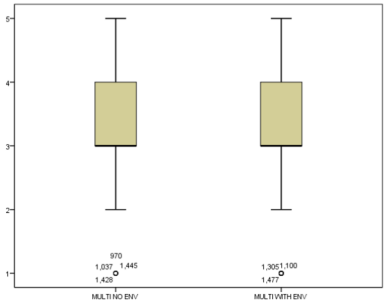
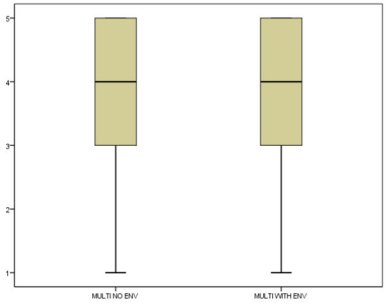
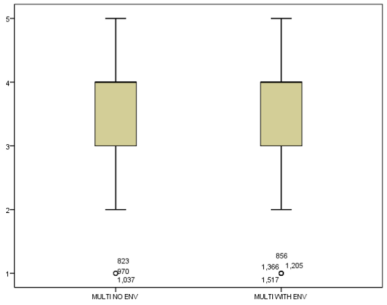
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab07.6	Dynamic Body Coordination	AUTO	21	2.81	0.928		F(4, 167)=1.02, ns
		COMM	28	3.14	1.177		
		NAV	9	2.78	0.441		
		SURV	19	3.05	1.433		
		ENV	92	3.30	1.077		
Ab07.7	Gross Body Equilibrium	AUTO	21	2.81	0.928		F(4, 167)=1.93, ns
		COMM	28	3.07	1.184		
		NAV	9	3.00	0.707		
		SURV	19	3.26	1.240		
		ENV	92	3.46	1.063		
Ab07.8	Stamina	AUTO	21	2.52	0.873		F(4, 167)=2.31, ns
		COMM	28	3.00	1.277		
		NAV	9	3.11	0.782		
		SURV	19	3.05	1.471		
		ENV	92	3.28	1.132		

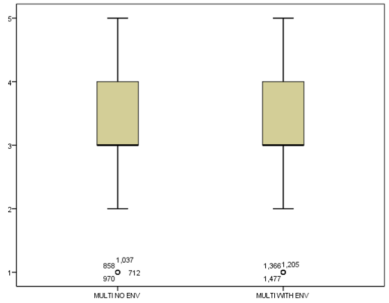
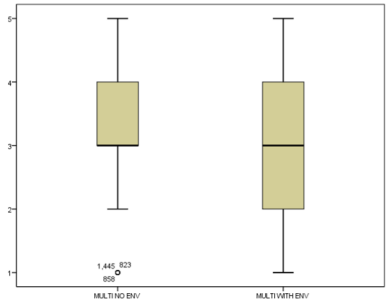
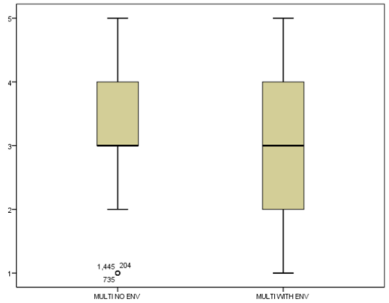
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab08.1	Manual Dexterity	AUTO	22	3.36	0.902		F(4, 168)=1.17, ns
		COMM	28	3.46	0.922		
		NAV	10	3.50	1.179		
		SURV	18	3.78	1.263		
		ENV	90	3.84	1.080		
Ab08.2	Finger Dexterity	AUTO	22	3.50	0.802		F(4, 168)=0.95, ns
		COMM	28	3.46	0.922		
		NAV	10	3.50	1.179		
		SURV	18	3.89	1.132		
		ENV	90	3.82	1.066		
Ab08.3	Arm-Hand Steadiness	AUTO	22	3.45	0.858		F(4, 168)=0.83, ns
		COMM	28	3.39	0.956		
		NAV	10	3.20	1.033		
		SURV	18	3.72	1.179		
		ENV	90	3.69	1.108		

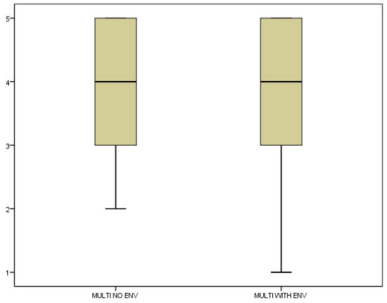
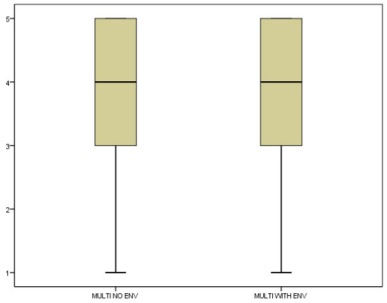
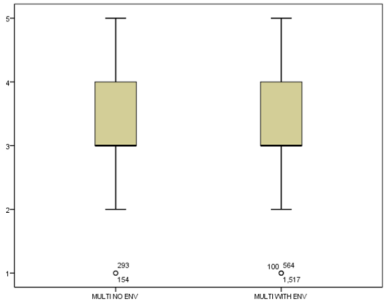
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab08.4	Precise Use of Controls	AUTO	22	3.14	0.889		F(4, 167)=1.57, ns
		COMM	28	3.50	0.923		
		NAV	10	3.40	1.075		
		SURV	18	3.67	1.372		
		ENV	90	3.81	1.101		
Ab08.5	Multi-Limb Coordination	AUTO	22	3.18	1.006		F(4, 168)=0.75, ns
		COMM	28	3.43	0.879		
		NAV	10	3.20	1.229		
		SURV	18	3.61	1.420		
		ENV	90	3.63	1.156		
Ab08.6	Sensory-Motor Coordination	AUTO	22	3.18	0.958		F(4, 165)=1.70, ns
		COMM	28	3.36	0.951		
		NAV	10	3.10	1.101		
		SURV	18	3.67	1.372		
		ENV	90	3.72	1.092		

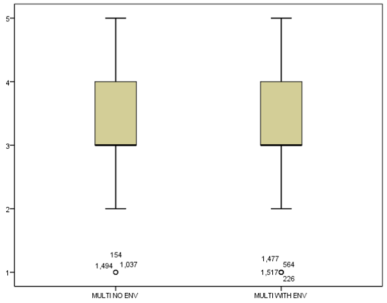
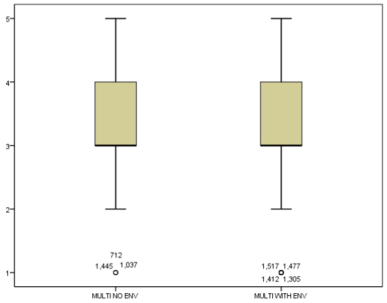
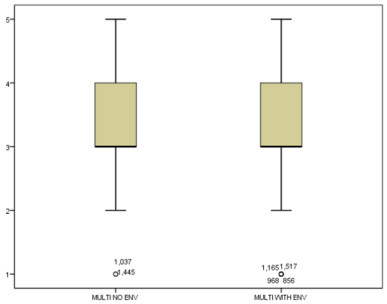
ID	Description	Specialty	N	M	SD	Boxplot of Ratings of Ability Importance by SSC type[1]	Overall F-Test
Ab08.7	Response to Competing Stimuli	AUTO	22	3.32	0.945		F(4, 166)=1.07, ns
		COMM	28	3.36	0.911		
		NAV	10	3.30	1.160		
		SURV	18	3.67	1.372		
		ENV	90	3.71	1.084		

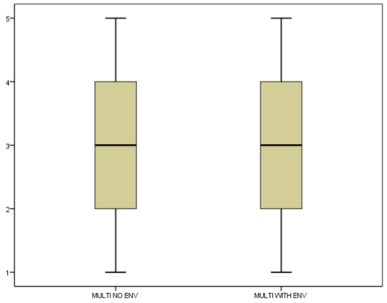
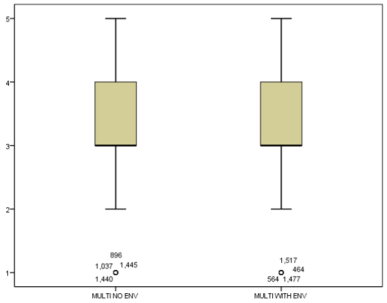
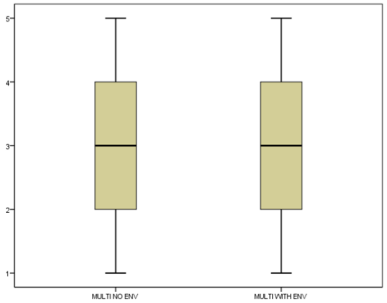
Appendix G: Descriptive statistics for and ANOVA of Ability importance ratings by multi-specialty SSC type

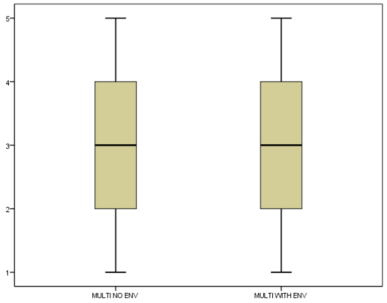
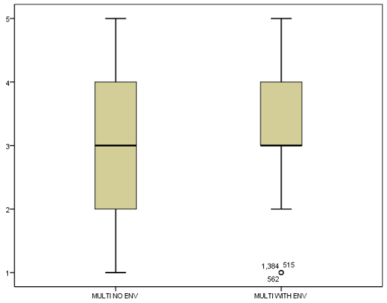
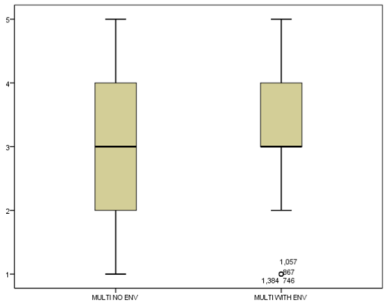
ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb01.1	Far Vision	MULTI–ENV MULTI+ENV	120 240	3.28 3.25	1.012 0.986		F(1, 358)=0.07, ns
ImpAb01.2	Near Vision	MULTI–ENV MULTI+ENV	121 240	3.79 3.84	0.976 0.915		F(1, 359)=0.29, ns
ImpAb01.3	Depth Perception	MULTI–ENV MULTI+ENV	120 240	3.58 3.56	0.967 1.013		F(1, 358)=0.04, ns

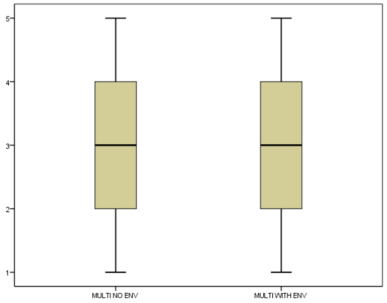
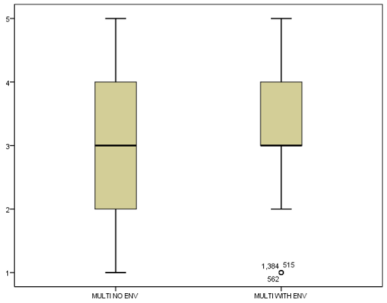
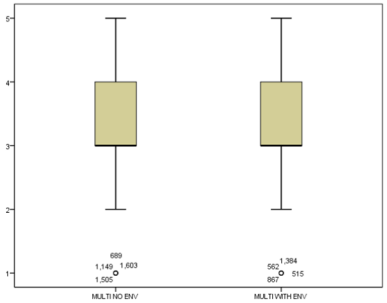
ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb01.4	Peripheral Vision	MULTI–ENV MULTI+ENV	120 238	3.35 3.36	1.066 1.000		F(1, 356)=0.01, ns
ImpAb01.5	Night Vision	MULTI–ENV MULTI+ENV	121 239	3.23 3.08	1.086 0.978		F(1, 358)=1.80, ns
ImpAb01.6	Glare Tolerance	MULTI–ENV MULTI+ENV	120 239	3.20 3.07	1.042 0.983		F(1, 357)=1.32, ns

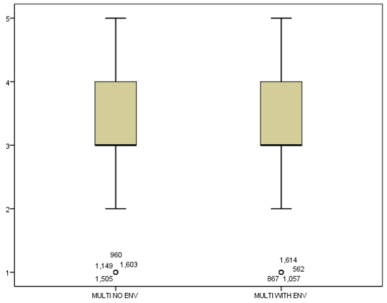
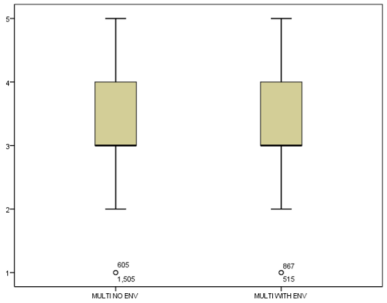
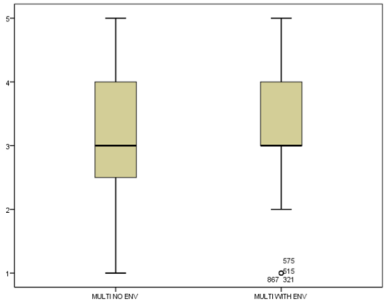
ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb01.7	Color Detection	MULTI–ENV MULTI+ENV	121 239	4.07 4.09	0.914 0.964		F(1, 358)=0.02, ns
ImpAb01.8	Color Discrimination	MULTI–ENV MULTI+ENV	121 237	3.94 3.93	0.925 1.021		F(1, 356)=0.02, ns
ImpAb01.9	Auditory Detection	MULTI–ENV MULTI+ENV	119 236	3.33 3.33	0.949 0.915		F(1, 353)=0.01, ns

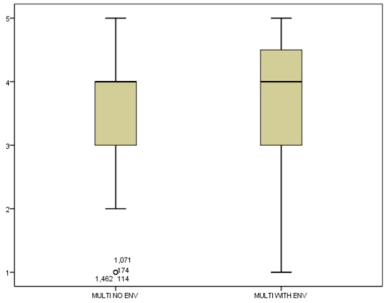
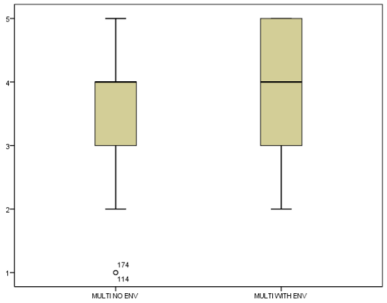
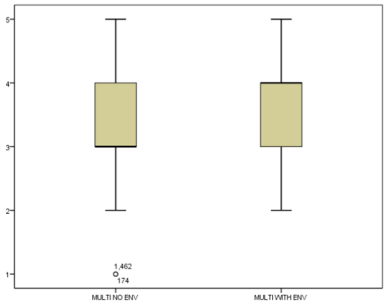
ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb01.10	Auditory Discrimination	MULTI–ENV MULTI+ENV	118 236	3.27 3.30	0.949 0.971		F(1, 352)=0.08, ns
ImpAb01.11	Auditory Attention	MULTI–ENV MULTI+ENV	119 236	3.32 3.23	0.938 1.007		F(1, 353)=0.61, ns
ImpAb01.12	Sound Localization	MULTI–ENV MULTI+ENV	118 234	3.31 3.35	0.920 1.000		F(1, 350)=0.14, ns

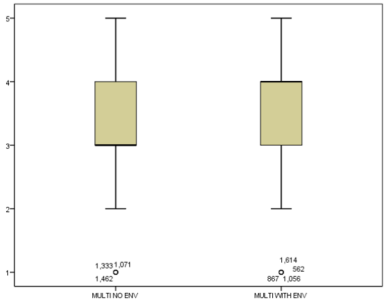
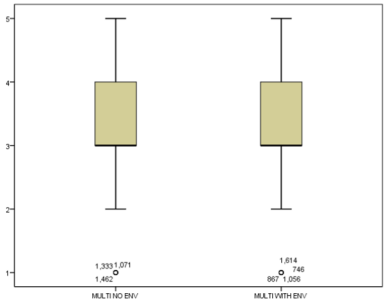
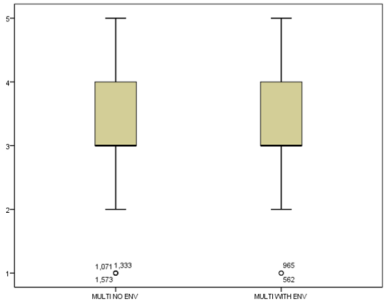
ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb01.13	Olfactory Discrimination	MULTI–ENV MULTI+ENV	118 236	3.00 3.01	1.125 1.029		F(1, 352)=0.01, ns
ImpAb01.14	Tactile Discrimination	MULTI–ENV MULTI+ENV	117 236	3.20 3.19	1.044 0.979		F(1, 351)=0.00, ns
ImpAb01.15	Proprioception	MULTI–ENV MULTI+ENV	118 236	3.12 3.10	1.072 1.089		F(1, 352)=0.03. ns

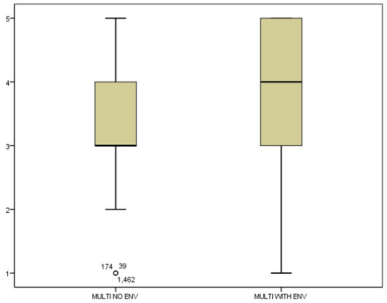
ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb01.16	Haptic Identification	MULTI–ENV MULTI+ENV	119 236	3.10 3.04	1.053 1.049		F(1, 353)=0.28, ns
ImpAb07.1	Trunk Strength	MULTI–ENV MULTI+ENV	135 181	3.20 3.31	0.999 1.018		F(1, 314)=0.91, ns
ImpAb07.2	Static Strength	MULTI–ENV MULTI+ENV	135 181	3.22 3.26	1.020 1.035		F(1, 314)=0.10, ns

ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb07.3	Dynamic Strength	MULTI–ENV MULTI+ENV	135 181	3.05 3.19	1.046 1.017		F(1, 314)=1.46, ns
ImpAb07.4	Dynamic Flexibility	MULTI–ENV MULTI+ENV	135 181	3.15 3.24	1.033 1.030		F(1, 314)=0.58, ns
ImpAb07.5	Extent Flexibility	MULTI–ENV MULTI+ENV	135 178	3.17 3.29	1.019 1.033		F(1, 311)=1.08, ns

ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb07.6	Dynamic Body Coordination	MULTI–ENV MULTI+ENV	136 180	3.28 3.28	1.059 1.036		F(1, 314)=0.00, ns
ImpAb07.7	Gross Body Equilibrium	MULTI–ENV MULTI+ENV	135 181	3.34 3.39	0.971 0.952		F(1, 314)=0.22, ns
ImpAb07.8	Stamina	MULTI–ENV MULTI+ENV	135 180	3.17 3.24	1.026 1.032		F(1, 313)=0.34, ns

ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb08.1	Manual Dexterity	MULTI–ENV MULTI+ENV	136 180	3.59 3.76	1.036 0.930		F(1, 314)=2.43, ns
ImpAb08.2	Finger Dexterity	MULTI–ENV MULTI+ENV	136 180	3.63 3.84	0.965 0.898		F(1, 314)=3.84, ns
ImpAb08.3	Arm-Hand Steadiness	MULTI–ENV MULTI+ENV	134 180	3.49 3.65	1.046 0.924		F(1, 312)=1.99, ns

ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb08.4	Precise Use of Controls	MULTI–ENV MULTI+ENV	135 179	3.44 3.61	1.076 1.007		F(1, 312)=2.11, ns
ImpAb08.5	Multi-Limb Coordination	MULTI–ENV MULTI+ENV	134 180	3.40 3.53	1.091 1.027		F(1, 312)=1.08, ns
ImpAb08.6	Sensory-Motor Coordination	MULTI–ENV MULTI+ENV	135 178	3.41 3.57	1.046 0.979		F(1, 311)=2.07, ns

ID	Ability	SSC Type	N	Mean	SD	Boxplot of Ability Importance Rating[1] by SSC type	Overall F-test
ImpAb08.7	Response to Competing Stimuli	MULTI–ENV MULTI+ENV	135 178	3.51 3.67	0.984 1.040		F(1, 311)=1.84, ns

Notes: Importance rating scale 1=*Not important*; 2=*Somewhat important*; 3=*Important*; 4=*More important*; 5=*Extremely important* to successful job performance