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Scaling the Information Processing Demands of Occupations

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Abstract

The purpose of this study was to provide additional validity evidence for a model of person-environment fit based on polychronicity, stimulus load, and information processing capacities. In this line of research the confluence of polychronicity and information processing (e.g., the ability

of individuals to process stimuli from the environment along five dimensions of information load, interpersonal load, change load, time structure, and activity structure) is applied to the occupational environment. Using magnitude estimation scaling, college students in the United States and Portugal rated 42 occupations across five information processing demand characteristics. Results indicated that occupations could be differentiated by the information load conditions, thus producing a profile of information processing demand characteristics unique to each of the occupations tested. Additional findings provided evidence for the validity of the scaled occupational values; ratings differed reliably across Holland categories, were fairly consistent across the two cultural groups, and showed expected relationships with salary and educational level.

Key words: polychronicity; information processing capacity; person-environment fit; magnitude estimation scaling; cross-cultural validity; information load; occupational scales

Scaling the Information Processing Demands of Occupations

Just as occupations differ along many dimensions such as income level, education required for entry, and characteristic activities, individuals who seek occupations differ along many dimensions including interests, values, skills, cognitive abilities, and educational background (Donnay & Borgen, 1996; L. S. Gottfredson, 2003; Holland, 1997). The notion of matching the capacities of persons with the demand characteristics of occupations in order to achieve greater harmony in the work-life space has occupied a central place in the history and practice of vocational psychology, and person-environment (P-E) fit theories continue to play an integral role in vocational psychology (Holland, 1997; Lofquist & Dawis, 1991). The purpose of the current study was to replicate and extend research on an emerging view of P-E fit based on the notions of polychronicity, temperament and information processing capacities of stimulus overload.

The P-E fit paradigm has been prominent in the vocational literature for decades (Savickas, 2000). Although much of the P-E fit literature has focused on the match in vocational interests, skills or abilities (Holland, 1997; Lofquist & Dawis, 1991), in this study we offer an additional P-E perspective that has the potential to facilitate the vocational decision-making process. This proposed perspective is focused on individual differences in temperament and emotional tone that may bear upon the extent to which an individual can tolerate or cope with stimulus overload emanating from several sources (Haase, 1986). The fundamental premise of this line of research is that the successful negotiation of an environment requires that the individual have sufficient capacity to meet the stimulus demand characteristics of the environment. This idea is not new in psychology; its modern manifestation can be found in the classic literature in cognitive psychology on optimal arousal and information processing (G. A. Miller, 1959; Weaver & Shannon, 1963) as well as the more contemporary research on concepts such as multitasking, single versus dual

channel and parallel versus serial information processing (Logan, 2002; Pashler, 1994; Pashler & Wixted, 2002; Wiener & Nagel, 1988). Based on this literature, it is plausible to conclude that environmental stimuli vary from mild to intense and emanate from a variety of sources, and that individuals differ significantly from one another in their capacity to process information from a variety of sources. It can be inferred, then, that person-environment interactions have a higher probability of success when the information processing capacities of the individual are matched to the informational demand characteristics of the environment.

Haase and colleagues (Haase, Lee, & Banks, 1979; Haase 1986) put forth a five-dimensional model of individual differences in the ability to cope with stimuli or demands from the environment based on research and theory from the constructs of polychronicity, temperament and information processing. More recently, Haase, Ferreira, Santos, Aguayo and Fallon (2008) extended the five dimensions defined by the interface of constructs from polychronicity and information processing to describe both persons and occupational environments, with the goal of developing a P-E fit model based on these concepts. The purpose of the current study was to extend this previous work by expanding the coverage of the occupations studied, and to provide additional validity evidence for differentiating occupations based on the same five dimensions of information processing that Haase et al. (1979) used to describe variation among individuals. In the current study we focused on increasing the number of occupational scales, re-scaling the information load demands of these occupations, assessing the validity of the these scale values across two cultural contexts (United States and Portugal), and exploring the degree to which the new occupational scale values could be related to theoretically-relevant criteria (salary and educational level).

Polychronicity, Stimulus Overload, Information Processing Capacity, and Temperament

The detailed arguments that suggest an interface between polychronicity, capacity for tolerating stimulus overload, and capacity for information processing among individuals and comparably defined demand characteristics of occupations are given in some detail in Haase et al. (2008). We briefly recount the central constructs here to set the stage for the replication and extension of the current study.

Polychronicity is a construct introduced by the cultural anthropologist Edward Hall (1959, 1966) to describe a taxonomy of how individuals across cultures handle both time and space (proxemics) in their day to day dealings with other individuals and their environment. Hall coined the term *polychronic* to characterize cultures for whom time and space are relatively fluid and flexible, and the term *monochronic* to characterize cultures that are more constrained and inflexible in their approach to time and space. Monochronic individuals in polychronic cultures, and polychronic individuals in monochronic cultures, report considerable distress when one's cultural training is at odds with environmental demands (Haase, et al., 1979; Haase, 1986; Hall, 1959, 1966). This taxonomy can easily be applied to individual differences within a culture—individuals will vary considerably in their characteristic tendencies for handling their interactions with others and with their environment. From an individual differences perspective the central point to be gleaned from this literature is that a mis-match between personal characteristics and environmental demands can be stressful, and it can be inferred that most individuals will seek ways to reduce such stress.

The fact that such mis-matches may be stressful is amply supported by evidence from other lines of psychological research in the areas of attention, perception, stimulus overload, and information processing capacities. Beginning with the work of G. A. Miller (1959) that established that human information processing is limited by 7 ± 2 bits of information (and even less for social

information; Bieri et al., 1960) it has been well established that these limits are hampered even further by stimulus overload and other limits of attentional and perceptual capacities (Broadbent, 1971; J. G. Miller, 1961; Millord & Perry, 1977; Wohwill, 1974). These ideas that stimulus and information overload can have deleterious effects on performance and psychological status have been reaffirmed in the more contemporary literature of cognitive psychology (Logan, 2002; Pashler, 1994). There seems to be little question that multitasking—a condition of stimulus overload—can overtax the resources of the individual both functionally (behavior) and structurally (brain) and can have serious consequences for productivity and behavioral efficiency (Gopher, Armony, & Greenspan, 2000; Meyer & Kieras, 1997; Rogers & Monsell, 1995). While these results establish the demands that can be placed on individuals, it is also clear that there can be vast variation between individuals in terms of their abilities to cope with such demanding situations.

A third line of reasoning and research that bears upon the work described here derives from contemporary manifestations of Pavlov's (1951) dimensions of temperament which he called "strength of the nervous system" and defined as individual differences in the capacity of the cells in the central nervous system to process information. A considerable body of evidence (Neblitsyn & Gray 1972; Newberry et al., 1997; Strelau, 1979, 1997) suggests that the Pavlov's constructs of excitation, inhibition, mobility and balance are dimensions of temperament and are a plausible biological substrate that helps explain the variation among individuals and the manner in which they respond to stimulus rich and stimulus deprived environments. Polychronic and monochronic styles have been shown to be reliably differentiated by these Pavlovian temperamental constructs (Ferreira, Santos, Haase, Connacher, Roy, & Jome, 2008; Haase, 1986; Haase, Ferreira, Santos, & Tulley, 2005; Haase, Conacher, Roy, Jome, Ferreira, & Santos, 2008). All of these lines of research lead to one central conclusion: individuals vary in their capacities for processing

information from both interpersonal and environmental sources and they vary in their capacities for tolerating stimulus.

Five Dimensions of Individual Information Processing Capacities

A five factor measure designed to assess individual differences in information processing capacity that resulted from the confluence of polychronicity, stimulus overload, information processing and temperament is described in Haase et al. (1979). The five factors that were adduced for understanding the individual differences in the capacity to tolerate differing degrees, and different types, of stimulus and information overload included the following:

- *information overload* : the capacity to tolerate situations in which many pieces of information are being presented simultaneously or in close succession,
- *interpersonal overload:* capacity to tolerate the presence of interpersonal interactions, such as being in a crowd or needing to attend to others,
- *change overload*: capacity to deal with situations in which stimulus inputs in the environment are rapidly fluctuating,
- *time structure:* preference for greater control over the scheduling of activities in a temporal sequence, and
- *activity structure:* preference for a control over type and sequence of activities

The scale for measurement of these dimensions has been shown to be significantly related to a variety of constructs and has been shown to predict individual differences in performance in multitasking situations (Dumont & Vamos, 1975; Haase, Lee, & Banks, 1979; Haase, 1986; Haase, Ferreira, et al., 2008).

Initial Study of the Scaling the Information Load of Occupations

Based on the previous theory and research, there is evidence for systematic variation between *individuals* in their capacity to tolerate environmental stimulus conditions that emanate from both personal and non-personal sources. In a parallel fashion, it is plausible to suggest that occupations would also vary considerably along these same five dimensions. Based on a P-E fit perspective we speculated that *occupations* might posses a variety of differing characteristics that could be quantified in terms of the stimulus demands that an occupation may place upon its practitioners. For example, some occupations may be substantially loaded with demands to process visual, intellectual, non-personal information (e.g., air traffic controller) while other occupations may be largely in the domain of high interpersonal demands (e.g., psychotherapist, customer service representative). Other occupations may have heavy demands associated with the mastery of rapidly changing information (e.g., stock broker), while yet other occupations place serious demands on the occupants to structure the timing and sequence of events (e.g., construction supervisor).

In our first study (Haase, Ferreira, et al., 2008) we employed the psychophysical procedure of magnitude estimation scaling (Gescheider, 1997; Stevens, 1966, 1975) to estimate scale values for each of the five information processing dimensions described above on each of 24 different occupations equally distributed across Holland's (1997) RIASEC taxonomy. We found that this magnitude scaling task was successful when completed by undergraduate students in the United States and Portugal who were able to reliably ascribe magnitude to the extent to which different occupational titles varied in their demand characteristics for information processing across the five dimensions (information, interpersonal, change, time, and activity). The magnitude estimated values of these 24 occupations established in this first study showed systematic differences across Holland types and across load types and these profiles were similar (with a few notable

differences) across the two culturally different samples. Additionally, the scale values for information load and change load were found to be significantly related to the average salary of the 24 occupations, and a statistically significant number of cases (31% versus 17% expected by chance) were accurately classified by a profile match between their individual capacities for information load and the demand characteristics of the occupations they chose. Initial validity was also obtained by noting the significant correlations between demand characteristics across occupations and other external criteria such as salary, necessary education and training required. Thus we considered our first attempt to scale the severity of informational demands of occupations to be successful, but with a few reservations. First we had limited the number of occupations to 4 per RIASEC category and within the initial set of 24 we discovered that certain of the occupations were not as well recognized in Portugal as in the US. Hence we felt it prudent to augment the number of occupations scaled to 42 (7 per RIASEC category), to insure that the occupation names were well recognized in both countries, and to replicate the magnitude estimation scaling study. In the tradition of Holmes and Rahe's (1967) magnitude estimates of the stress-illness relationship, having a reliable and valid set of magnitude estimates of the demand characteristics of the five dimensions would allow study of the possible consequences of P-E matches and mismatches between individual capacities and environmental demands.

The Current Study

The purpose of the current study was to replicate and further validate the profile of information processing demand characteristics of occupations, i.e., to quantify the degree to which occupations could be differentiated based on the five characteristics (information, interpersonal, change, time and activity). First, to broaden the reach of the occupational scales, the occupational list was expanded to seven occupations per RIASEC category, for a

total of 42 occupations (compared to 24 occupations used in Haase et al., 2008). The goal of the study was to assess the psychophysical characteristics of this expanded list of occupations, using magnitude estimation scaling (Stevens, 1975). Stevens (1966) referred to the technique of direct magnitude estimation as scaling of the "social consensus" as it is a process of establishing ratio scale values for perceptual phenomena that do not have an underlying physical metric. The fundamental technique for testing the validity of magnitude estimated scales is the fitting of power functions ($\hat{\psi} = aX^{\beta}$) that relate the unobservable underlying physical properties of the judgment to the psychological perception of magnitude.

It is traditional in magnitude estimation scaling to test the theoretical relationship between the obtained scale values and a proxy of the underlying physical scale such as a category rating scale of the same concepts (Stevens, 1975). In addition to the magnitude estimated ratings, we included a 9-point, Likert-type category rating of each of the 42 occupations for each of the five information processing types. If Steven's law of psychophysics governs the scaling then one should observe the typical nonlinear power function between the two scaling methods. Thus, additional evidence for the construct validity of the occupational scales was obtained by examining the relationship between the magnitude estimated scale values and the category scaled values.

Another goal of this study was to assess the degree to which the occupational scales based on the polychronicity and information processing dimensions are perceived similarly across cultures. Given that the construct of polychronicity may be rooted in biologically-based temperament, physiology and CNS processing (Haase et al., 1979; Haase, 1986), then in theory, the occupational ratings should be fairly immune to cultural influences and differences. Thus, implementing the

magnitude estimation procedure with two culturally different samples (drawn from Portugal and the United States) allowed for a test of the consistency of the quantification and provided an opportunity to study the validity of the major constructs embodied in the idea of information loads inherent in different occupations and the demands they create. We expected to find a similar pattern or profile of information processing dimensions across the two cultural groups.

Finally, in providing further evidence for the construct validity of the occupational scale values, we were interested in the degree to which the scale values would be related to occupationally-relevant criteria (i.e., salary and educational level). We hypothesized that increasing levels of compensation and education would correspond to increasing information processing demands across occupations.

Method

Participants

The respondents in this study included 375 university students (214 Portuguese, 161 American). The sample of Portuguese students consisted of 7% males and 93% females, while the American student sample was comprised of 39% males and 61% females. The Portuguese students ranged in age from 17 to 46 with a mean age of 20.4 years (*SD* = 2.7) and the American students ranged in age from 18 to 31 with an average of 20.2 years (*SD* = 2.2). Of the 214 Portuguese respondents, 208 identified their ethnicity as Portuguese, while 6 did not answer the item. Among the U.S. respondents 108 identified as Caucasian, 20 as Black/African American, 9 as Asian American, 9 as Hispanic/Latino, 2 as Native American, and 13 indicated "other."

Participants reported their occupational aspirations as well as major of study. The vast majority of the respondents were majoring in psychology, education or social sciences. Examining participants' occupational aspirations according to Holland type, most participants (70.6%)

identified a Social occupational choice, while 11.6% reported an Enterprising occupation, and 9.9% an Investigative. The remaining three categories (Realistic, Artistic, and Conventional) contained 2.6% of the sample each. Twenty-nine percent of U.S. respondents reported that their fathers held college or graduate degrees compared to 19% of Portuguese respondents. Similarly, 65% of mothers of the U.S. respondents held college or graduate degrees compared to 41% of mothers of the Portuguese respondents.

Stimulus Materials and Procedure

Magnitude Estimated Ratings. Magnitude estimation scaling is a method of psychophysics (Stevens, 1975) for assigning numeric values to objects that have ratio scale properties and thus provide ratio scale comparative judgments about objects along any dimension. The method has been used successfully to scale the severity of stressful events, the length of prison sentences for varying crimes, the popularity of wristwatches, and the prestige of occupations (Holmes & Rahe, 1967; Stevens, 1975). To obtain the magnitude estimated scale values for the occupations across the five information load conditions, participants were provided with a list of 42 occupations and asked to provide a numeric value to each occupation for each of the five information load conditions. The 42 occupations were chosen to represent Holland's (1997) hexagonal arrangement of occupations (seven occupations within each of the six Holland types). Occupations were selected that were commonly known (i.e., they appear on both the Strong Interest Inventory and the Vocational Preference Inventory) and used in sources of vocational information such as O*NET (U.S. Department of Labor, 2010). Occupations were chosen by the first four authors to represent different levels of training and compensation, and whose titles have the same meaning in both cultural contexts (i.e., Portugal and the Unites States). The 42 occupations appear in Table 1.

Participants were provided with the following instructions:

Magnitude estimation scaling is a method that allows you to make comparative judgments about the value of objects. For example, if you were asked to judge the *usefulness* of modes of transportation, and automobile is arbitrarily assigned 50 units of usefulness, you might make the following judgments:

Automobile 50 Airplane 25 Bicycle 10

in which you are judging an airplane to be ½ the value of automobile, and automobile as five times more valuable than bicycle. You can use any numbers you like to record your judgments to reflect the relative value of the objects.

As another example, you might judge the relative *importance* of a library, the Internet, and other people as sources of information about travel. If library is arbitrarily assigned 50 units of value, you might make the following judgments:

Library 50 Internet 100 Other People 5

in which you are judging the internet to be two times more important than a library, other people to be 20 times less informative than the internet, and the library to be 10 times more informative that other people.

Participants then judged the extent to which each of the 42 occupations was considered to have relative amounts of information load, interpersonal load, change load, activity structure, and time structure. For example, the directions for rating the Information Load dimensions began with the following: *Some occupations may have little load or information processing demands placed on a worker over the course of a typical day, while other occupations may have very high information demands placed on the worker during a typical day*. For each rating task, a standard occupation (i.e., Engineer) was assigned a value of 50 and the remaining 42 occupation names were judged against this standard. It is

this direct estimation comparative judgment process that yields optimal ratio scale values for each occupational title (Gescheider, 1997; Stevens, 1975).

Category Ratings. In addition to the magnitude-estimated ratings, participants rated the 42 occupations on the same five information processing dimensions mentioned above using a 9-point Likert-type rating scale. The scale ranged from 1 (very low load) to 9 (very high load).

Salary and Educational Level. Annual salary data and educational level (defined as percentage of college educated individuals within each occupation) for each of the 42 occupations was obtained from O*NET (U. S. Department of Labor, 2010).

Results

The Magnitude Estimated Scale Values

Table 1 contains the magnitude estimated scale values for each of the 42 occupations clustered by Holland type for both the American and Portuguese samples. The average estimated load value of the seven occupations within each Holland types is also included in Table 1. The magnitude estimated scale values are ratio scaled and can be interpreted as ratios of magnitude across pairs of occupations, occupational groups (i.e., Holland type), or countries. For example, the Information Load estimated for Physician by American participants was approximately twice the Information Load for Carpenter (64:31), while the Information Load for Physician estimated by the Portuguese participants was four times greater than the Information Load of Carpenter (81:21). Similarly, the Interpersonal Load estimated for Biologist by the American participants is approximately half of the Interpersonal Load estimated for Social Worker (34:66); approximately the same ratio (35:76) was estimated by the Portuguese participants. Similar comparisons suggest considerable face validity to the scale values that emerged from the scaling task.

The Power Function Relationship between Magnitude-Estimated and Category Scale Values

The power function $\hat{\psi} = \alpha X^{\beta}$ was used to predict the category ratings from the magnitude-estimated scale values for each of the five information processing dimensions. In the power function the value α is a constant scaling parameter with little interpretive value. The parameter estimate β documents the exponential rate of increase in psychological perception of magnitude given the underlying magnitude estimated scale. The expectation for the relationship between psychological perception of magnitude and the underlying scale is a decelerating positive function with diminishing returns setting in as the physical (magnitude estimated) scale increases. The values of α and β were estimated by a linear model applied to log-log coordinates (Stevens, 1975), and the values of *r* from the log-log linear model are measures of goodness of fit of model to data. The power functions of the three dimensions of Information Load ($\hat{\psi} = \alpha X^{\beta} = .475X^{.679}$, $r = .961$, $p < .01$), Interpersonal Load ($\hat{\psi} = \alpha X^{\beta} = .317X^{.747}$, $r = .956$, $p < .01$), and Change Load ($\hat{\psi} = \alpha X^{\beta} = .315X^{.753}$, $r = .960$, $p < .01$) were substantial and statistically significant. Power functions are expected to decelerate in slope at the higher values of the horizontal axis and this theoretically expected shape was found for Information Load, Interpersonal Load, and Change Load. The power functions for Activity ($\hat{\psi} = \alpha X^{\beta} = .556X^{.599}$, $r = .695$, $p < .05$) and Time Structure ($\hat{\psi} = \alpha X^{\beta} = .573X^{.589}$, $r = .501$, $p < .05$) were statistically significant; however, the expected power function pattern was not found as clearly for these two dimensions.

Cross-Cultural Comparisons of Occupational Profiles

Both the American and Portuguese participants provided magnitude estimated ratings of the 42 occupations across the five information processing dimensions, yielding a total 210 mean scores per participant, with 420 mean scores total. These 420 mean scores were also cross-classified by each of the six Holland types within which occupations were clustered. A 2 x 5 x 6 Analysis of

Variance was conducted to test the differences between profiles of load types and Holland types across the two countries. The means and standard deviations of this 60-cell factorial arrangement are shown in the RIASEC summary rows of Table 1.

The results of the ANOVA indicated that the average scale value of the Portuguese sample was significantly higher than for the American sample ($F(1, 360) = 33.12$, $p < .001$, $\eta^2 = .08$), the average scale value of the load types differed significantly from one another ($F(4, 360) = 19.04$, $p < .001$, $\eta^2 = .18$), and the average scale value differed significantly across Holland types, ($F(5, 360) = 74.80$, $p < .001$, $\eta^2 = .51$). More importantly, the *profile* of the Portuguese participants, while significantly elevated, does not differ significantly from the shape of the profile of the American subjects. The Country x Load type interaction was not significantly different from zero ($F(4, 360) = .68$, $p = .61$, $\eta^2 = .007$). The three-way Country x Load type x Holland type interaction was statistically significant ($F(20, 360) = 2.12$, $p < .003$, $\eta^2 = .11$), revealing that although the load profiles differed in elevation but not shape across American and Portuguese subjects, the profiles are not uniform across Holland categories.

In order to assess these profile patterns, we evaluated the simple two-way Country x Holland type interactions within each of the five information loads (Maxwell & Delaney, 2004). Plots of the Portuguese and American Holland type profiles for each of the five load types are displayed in Figure 1. The Country x Holland type simple interactions were found to be significantly nonparallel for Information Load ($F(5, 72) = 3.45$, $p < .008$, $\eta^2 = .19$), for Change Load ($F(5, 72) = 3.14$, $p < .013$, $\eta^2 = .18$), and for Time Structure ($F(5, 72) = 9.15$, $p < .001$, $\eta^2 = .39$). No significant simple interactions were observed for Interpersonal Load ($F(5, 72) = 2.07$, $p < .078$, $\eta^2 = .13$) or Activity Structure ($F(5, 72) = 1.25$, $p < .295$, $\eta^2 = .08$).

Despite the significance of three of these simple interactions, we are struck by the apparent visual similarity of the shape of the profiles of the two countries for the first four information processing dimensions (Figure 1a – 1d). The notable exception to this pattern is seen in Figure 1e for the time structure dimension. For this information load dimension what catches our attention is the relative homogeneity of the estimated scale values for the six Holland types for the Portuguese students compared to the relative heterogeneity of the estimates from the American students. Thus the American students see far greater differences in time structure demands between RIASEC occupations than do the Portuguese students. The Portuguese mean estimates across RIASEC types range from 45 to 48 (M = 46.5, SD = 0.8) while the American mean estimates across the RIASEC types range from 39-50 (M = 43.8, SD = 3.8). Although the average ratings are similar, the standard deviations differ by a factor of about 4.75.

Relationships Between Occupational Scale Values and Theoretically-Relevant Criteria

The linear models for salary and educational level as a function of magnitude estimated values were fitted for the American sample for all five load types. Correlations and unstandardized slope coefficients for the five separate load types are presented in Table 2. Salary and Information Load were significantly correlated (r = .765) and the slope of the fitted regression function for Salary based on the Information Load values was b = $2141, indicating that every one unit increase in information load demand of an occupation was associated with a $2141 increase in compensation. In other words, high information demand occupations (e.g., physician, veterinarian) are better paid than low information demand occupations (e.g., plumber, photographer). A similar pattern was observed for the relationship between Information Load and Educational Level (r = .70, p < .01), such that every one unit increase in rated information load demand is associated with a 2.2% increase in the percentage of college graduates in the occupation. That is, high information

demand occupations (e.g., Physician) contain more individuals with college degrees and higher salaries than low information demand occupations (e.g., Truck Driver). Interpersonal Load was less steeply related to Salary (b = \$615, r = .246) and Educational Level (b = 1.2%, r = .423) than was the Information Load dimension. In general, the magnitude estimated values affiliated with each load type are consistent with both compensation and educational level that also vary across occupations.

Discussion

One of the main purposes of this study was to broaden the number of occupational scales, and the results showed that the 42 occupations scaled in this study could clearly be distinguished across the five information processing dimensions of information load, interpersonal load, change load, activity structure, and time structure. Consistent with the findings from Haase et al. (2008), the magnitude estimation technique was successfully employed to create occupational scales in which different occupations were rated as having varying degrees of information processing demands.

An examination of the mean scores on the occupational scales revealed patterns that are consistent with stereotypical notions about how occupations differ. Profiles of occupations emerged in which both individual occupations and clusters of occupations by Holland type showed expected levels of demand for the various information processing loads. For example, the interpersonal demand characteristics are clearly seen to be most demanding in the social occupations and least important to the realistic occupations. Investigative occupations are judged to have the highest informational load demands and the highest change load demands, while realistic and conventional occupations are rated as relatively low on such demands. These patterns in the scale values provide evidence of face validity for the occupational scales.

The current magnitude estimated scale values established for the 42 occupations were also found to behave as expected when considering the classical power function that the scale values should have with the comparable category rating scales of the same constructs. The power functions fitted to the information, interpersonal, and change loads between the magnitude estimated values and the category scales clearly show the positively decelerating functional relationship. The activity and time structure dimensions, however, had excessive variability such that the same pattern was not clearly visible; thus, the results for those two dimensions are more tentative. It is possible that undergraduate students have somewhat stereotypical, less nuanced understandings of different occupations and that in order to judge the activity and time structures for an occupation, one would need a more complex, nuanced understanding of that occupation. That is, a college student with a general understanding of the occupation of biologist might easily deduce that the occupation of biologist would require a high demand for information and change, but unless the students had more specific knowledge of the occupation such as different jobs that a biologist might hold, or the daily work activities of a biologist, it would be more difficult to estimate the time and activity structure for that occupation. Another speculation about the more tentative findings for time and activity structure is that participants needed additional instructions in the rating task in order to understand what these two demand characteristics entailed.

The cross-cultural results provide additional evidence for the validity of the dimensions of polychronicity and information processing across cultures. The average occupational scale values from the Portuguese and American raters across Holland types showed a profile that differed in level, but not in pattern (with the exception of time structure). This finding indicates that the constructs are perceived across cultures in similar ways and that the occupations can be clearly distinguished by the five-dimension profile. The similarities between the two cultural groups are

especially noticeable for the information, interpersonal and change load dimensions. Interestingly, although the shape of four of the occupational profiles was remarkably similar, the Portuguese participants consistently rated the occupations higher on these information processing dimensions compared to the American participants. Using a smaller sample of Portuguese and American college students, Haase, Ferreira, et al. (2008) also found great similarity in the occupational profiles between the two groups, yet they noted group differences in the ratings of Artistic occupations, such that the Portuguese students rated Artistic occupations higher on many of the information processing dimensions.

Examination of Figure 2 reveals that despite the differences in elevation, the *shape* of the profiles of the first four information processing dimensions (2a – 2d) were remarkably similar for both Portuguese and American students. The notable exception to this pattern is seen in the profile for time structure. As can be seen in Figure 1e the profile of time structure ratings for the Portuguese students are confined to a relatively narrow range (e.g., flat profile), whereas the ratings of the American students are far more variable. The American students made far greater discriminations of time structure demands between occupations in RIASEC categories than did their Portuguese counterparts. It is possible that the different cultural systems governing the structure of work in the two countries is reflected in the relative homogeneity of time structure ratings for the Portuguese students. The student raters for this study were college students and the Portuguese authors of this work (JAF and EJRS) suggest that the homogeneity of the time structure ratings of the Portuguese students may reflect a relative inexperience with the day-to-day requirements of the work environment and practical opportunities to learn about different work environments. University-bound students in Portugal would rarely have had part time jobs, for example, a practice that is very common among college students in the U.S. Although speculative,

it is possible that cultural factors such as this play an important role in determining how individuals perceive the demand characteristics of occupations in the world of work, and future research could profit from additional tests of hypotheses about these differences.

The validity of the occupation scale values, especially for the American sample, is further supported by the observed relationships between the information processing demand characteristics of these 42 occupations and their associated levels of compensation and educational level. In general, the more demanding the occupation on the information processing dimensions, the higher the salary and educational level of individuals in that occupation as observed on the American participants of this study. We would anticipate similar results for the Portuguese sample as the salary and educational data may differ in absolute values but would be expected to have the same relative rank order. We also observed that increases in salary and education were not uniform across the 5 load types; some of the load types were associated with greater increases in salary and education than others. The more demanding the occupation in terms of information load, the higher the salary ($2,400 per unit) and the greater the percentage of individuals (2.1% per unit) in that occupation who have a college degree, yet a one-unit increase in interpersonal load was associated with an increase of approximately $600 – the lowest salary increase of all dimensions.

Future Research

The results of this study bear on the trustworthiness of the occupational scale values of 42 occupations. Given these encouraging findings, the next steps in this line of research are to more specifically examine P-E fit on polychronicity. The possibility that a match between a person and an occupation across the dimensions of stimulus demands we define here (information load, interpersonal load, change load, time structure and activity structure) is suggested in the vocational literature. Holland's notion of the resulting success, satisfaction, and longevity that derives from a

match between person and environment has been extensively documented. L. S. Gottfredson's (1980) validity study of Holland's hexagonal system verified that occupational environments can be differentiated on the basis of the demands inherent in that occupation. For example, low level social jobs were found to differ considerably in their demand for coping with interpersonal information from high level social occupations. Prediger's (1982) landmark study of the factor structure of occupations also supports the notion that the dimensions of data vs. ideas, and people vs. things are important in the differing demands contained in any given occupation across these two broad domains. Similar ideas of person-environment match across differing demand conditions is also seen in the internet-based O*NET (U.S. Department of Labor, 2010) in which the occupational skills that can be matched to occupational requirements are a prominent feature of self-evaluation of occupational interest and choice.

Ultimately, this P-E fit model may have utility in matching an individual's profile of coping with the various information processing loads with occupations that share a similar profile. Theoretically, an individual who shows an ability to cope with demands for information load and is working in an occupation with significant information load demands should have a higher probability of success, satisfaction, and longevity. Matching persons to occupational environments across all five dimensions should raise that probability even further. In the current work, we have established the scale values such that a 5-dimensional, information load profile can be established for each of the 42 occupations, each of the 6 RIASEC types, or any combination thereof, including a specific set of occupations that any respondent might choose—we have established one half of the P-E fit paradigm. In our future work we hope to more firmly document the second half of the P-E fit paradigm, that is, a profile of *individual capacities* for tolerating information loads across the five dimensions. As a practical matter having a profile of individual capacities for these five

dimensions that can be matched to a profile of occupational demands could be useful in considering pursuit of an occupation. Such profile matching may be a useful adjunct to, not a replacement for, other well established P-E fit schemes based on interests, values, and abilities (Holland, 1997; Lofquist and Dawis, 1991) that have been profitably used in vocational counseling for some time. Given the many changes that are taking place in the landscape of the world of work this PE fit strategy has the potential to provide individuals with an additional set of considerations that might assist them in making vocational choices.

Limitations

Several limitations should be noted in the present research. The sample of raters from both universities were undergraduates who were largely drawn from the Social, Enterprising and Conventional categories of Holland types and the average ratings could be influenced by these interest groups, and acquiring similar ratings from the remaining Holland types would be necessary to rule out the notion that ratings vary as a function of an individual's occupational interest. In this study we used college students to estimate the scale values. Although university students likely have formed clear images or stereotypes of occupations (Gottfredson, 2002) and thus can evaluate the environmental demands of occupations, they may have different levels of actual experience in the workforce. Given cultural differences, we suspect that the American students may have had more exposure to work experiences in their formative years, whereas university-bound Portuguese students tend to have less work experience; this fact may help to explain some of the observed differences in profiles between these two sets of raters. Additional research that is currently underway on the environmental demands of occupations is now focused on collecting data from working adults. A study of the magnitude estimated scale values of these 42 occupations obtained

from several hundred adults in occupations selected from each of Holland's RIASEC categories is currently underway to address these issues (Fernandes, Ferreira, & Haase, 2010).

As is true with all magnitude estimation scaling projects, there is considerable variability among the ratings for any single occupation and this variability is largely similar across the two student rater groups. It is not entirely clear why the Portuguese raters judged the four of the five information load dimensions as having higher demand characteristics than the U.S. raters. Clearly cultural factors are at work that might be explained by the differences in higher educational systems and by differences in understandings of the world of work. In future research it would be advantageous to better understand how definable cultural differences might affect an indiviidual's perceptions of, and adaptation to, the demand characteristics of occupations.

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Table 1

Magnitude Estimated Means and (Standard Deviations) for Information Processing Dimensions Across Holland Types for American and Portuguese Samples

	American Sample (n = 161)					**Portuguese Sample** (n = 214)				
Occupation	**INFO**	**INTER**	**CHA**	**ACT**	**TIME**	**INFO**	**INTER**	**CHA**	**ACT**	**TIME**
Realistic Occupations	***31***	***35***	***33***	***41***	***41***	***25***	***27***	***29***	***42***	***47***
	(16.91)	***(22.80)***	***(22.04)***	***(29.24)***	***(23.12)***	***(15.36)***	***(18.77)***	***(18.47)***	***(24.63)***	***(25.17)***
Auto Mechanic	36	37	40	43	40	25	29	33	44	48
	(15.57)	(20.95)	(22.73)	(22.58)	(22.68)	(15.56)	(18.95)	(19.01)	(24.51)	(24.07)
Carpenter	31	35	35	41	41	21	26	25	42	48
	(17.65)	(19.76)	(22.65)	(23.23)	(21.93)	(13.06)	(18.18)	(16.08)	(24.55)	(24.12)
Electrician	38	35	36	40	41	26	25	28	44	44
	(15.46)	(18.21)	(21.11)	(20.26)	(20.69)	(14.86)	(17.01)	17.31)	(22.85)	(23.01)
Farmer	30	46	38	50	44	24	20	27	42	51
	(19.12)	(37.08)	(26.16)	(66.34)	(25.79)	(18.78)	(16.72)	(20.91)	(26.90)	(32.36)
Plumber	29	32	27	37	39	22	25	25	40	45
	(16.52)	(21.14)	(19.54)	(22.03)	(22.23)	(13.52)	(17.44)	(16.66)	(24.11)	(25.44)
Construction Inspector	37	40	37	42	42	33	41	38	44	47
	(17.10)	(22.27)	(21.25)	(21.77)	(20.30)	(15.73)	(23.60)	(20.28)	(21.27)	(21.19)
Truck Driver	18	21	21	35	43	21	24	25	42	45
	(16.95)	20.23)	(20.85)	(28.43)	(28.24)	(15.98)	(19.46)	(19.04)	(28.21)	(25.97)
Investigative Occupations	***53***	***47***	***51***	***45***	***50***	***59***	***56***	***59***	***48***	***46***
	(24.37)	***(24.34)***	***(25.71)***	***(23.69)***	***(34.16)***	***(23.34)***	***(27.22)***	***(27.32)***	***(23.18)***	***(22.39)***
Biologist	57	34	55	42	48	49	35	50	43	45
	(25.85)	(23.20)	(25.38)	(20.99)	(64.77)	(20.84)	(19.29)	(23.02)	(18.87)	(20.22)
Physician	64	66	60	51	56	81	85	79	51	42
	(30.28)	(26.13)	(27.47)	(25.29)	(26.96)	(28.25)	(33.42)	(30.07)	(30.23)	(25.76)
Pharmacist	49	51	50	43	48	56	62	55	49	48
	94.34)	(24.02)	(25.45)	(22.15)	(24.90)	(20.46)	(26.47)	(25.23)	(22.40)	(21.99)
Computer Programmer	49	29	50	40	46	54	29	59	49	49
	90.20)	(21.99)	(26.98)	(24.98)	(49.66)	(22.18)	(18.18)	(33.32)	(23.00)	(23.44)
Dentist	53	57	47	46.92	55	59	66	56	49	49
	(22.95)	(25.18)	(23.40)	(23.61)	(25.74)	(23.65)	(31.98)	(27.27)	(21.52)	(22.76)
Medical Technician	49	45	50.08	45	46	57	62	60	48	44

	(23.84)	(23.87)	(26.56)	(24.82)	(21.46)	(24.89)	(32.99)	(26.58)	(24.16)	(22.33)
Veterinarian	51	49	49	47	50	58	51	56	46	46
	(23.11)	(25.96)	(24.73)	(23.98)	(25.65)	(23.14)	(28.22)	(25.77)	(22.08)	(20.25)
Artistic Occupations	***34***	***42***	***41***	***40***	***39***	***43***	***49***	***50***	***43***	***47***
	(23.34)	***(24.85)***	***(29.31)***	***(26.54)***	***(24.71)***	***(22.13)***	***(26.39)***	***(26.47)***	***(23.45)***	***(27.26)***
Architect	50	42	50	46	46	50	41	52	50	51
	(20.44)	(22.14)	(25.40)	(23.03)	(20.37)	(17.42)	(18.77)	(22.66)	(18.48)	(21.56)
Graphic Artist	32	27	45	40	38	40	33	53	41	49
	(18.07)	(18.16)	(47.05)	(25.33)	(23.49)	(20.29)	(19.97)	(28.89)	(23.38)	(27.12)
Librarian	29	45	26	35	39	33	48	33	49	48
	(20.10)	(24.84)	(23.74)	(26.07)	(24.68)	(20.67)	(26.78)	(21.67)	(27.28)	(40.57)
Musician	31	37	36	36	34	41	40	46	40	47
	(20.58)	(26.23)	(26.39)	(27.39)	(25.71)	(24.96)	(28.18)	(29.47)	(23.18)	(28.00)
Photographer	27	34	32	39	38	34	41	46	40	48
	(21.44)	(23.05)	(22.99)	(26.31)	(25.11)	(19.60)	(26.97)	(24.90)	(23.36)	(25.39)
Journalist	40	51	51	45	41	63	73	70	44	41
	(30.54)	(29.29)	(29.02)	(27.31)	(25.11)	(26.40)	(29.36)	(27.82)	(25.02)	(23.27)
Actor	29	55	44	43	39	40	65	52	40	44
	(32.18)	(30.23)	(30.57)	(30.33)	(28.47)	(25.55)	(34.67)	(29.92)	(23.43)	(24.91)
Social Occupations	***42***	***64***	***47***	***45***	***48***	***57***	***75***	***62***	***50***	***45***
	(24.20)	***(33.15)***	***(24.96)***	***(23.40)***	***(24.62)***	***(22.12)***	***(32.69)***	***(26.23)***	***(24.79)***	***(22.88)***
Elementary School Teacher	39	69	47	51	52	50	75	55	55	47
	(24.14)	(31.92)	(25.72)	(27.01)	(28.64)	(22.42)	(32.45)	(25.78)	(26.35)	(24.33)
Nurse	47	69	53	48	49	66	82	71	48	39
	(23.64)	(50.79)	(26.31)	(21.98)	(25.73)	(24.78)	(32.62)	(29.67)	(27.75)	(24.04)
High School Counselor	38	64	45	40	47	63	77	67	50	47
	(25.77)	(31.17)	(25.33)	(22.88)	(24.62)	(20.90)	(33.50)	(24.88)	(25.12)	(22.75)
Physical Therapist	46	57	45	46	47	54	66	57	50	45
	(25.88)	(26.12)	(22.64)	(22.00)	(21.91)	(21.87)	(32.49)	(25.12)	(23.43)	(21.21)
Social Worker	39	66	48	43	45	53	76	60	46	44
	(25.79)	(30.66)	(25.19)	(24.04)	(22.90)	(22.07)	(32.96)	(25.00)	(23.88)	(23.16)
Speech Pathologist	40	59	41	42	44	57	72	61	49	45
	(21.40)	(28.87)	(23.66)	(22.29)	(21.80)	(21.28)	(31.65)	(26.95)	(22.87)	(20.97)
Special Education Teacher	42	65	49	47	50	59	74	63	52	46
	(22.75)	(32.52)	(25.89)	(23.63)	(26.73)	(21.49)	(33.13)	(26.27)	(24.11)	(23.72)
Enterprising Occupations	***33***	***51***	***39***	***41***	***42***	***34***	***51***	***41***	***45***	***48***
	(20.14)	***(29.72)***	***(24.46)***	***(27.98)***	***(23.22)***	***(17.06)***	***(27.17)***	***(21.52)***	***(21.46)***	***(21.90)***

Life Ins Agent	32	50	37	38	40	30	46	40	47	48
	(19.57)	(43.59)	(24.97)	(23.49)	(21.11)	(16.18)	(24.30)	(19.51)	(20.92)	(22.00)
Salesperson	29	59	34	41	40	30	60	40	44	46
	(19.58)	(30.35)	(26.70)	(24.80)	(24.24)	(16.42)	(32.42)	(23.49)	(23.41)	(22.43)
Business Executive	49	56	55	46.79	53	49	51	51	50	50
	(22.76)	(26.63)	(24.93)	(25.04)	(24.92)	(20.36)	(24.86)	(22.38)	(21.20)	(21.43)
Real Estate Agent	33	50	41	41	42	30	52	39	41	46
	(21.58)	(27.01)	(25.86)	(20.98)	(21.61)	(14.30)	(30.53)	(20.07)	(18.56)	(22.42)
Store Manager	31	51	36	45	40	30	44	36	45	47
	(19.56)	(25.96)	(22.63)	(50.07)	(22.76)	(15.35)	(23.46)	(20.11)	(23.67)	(22.25)
Travel Agent	28	51	37	36	41	33	52	42	45	47
	(18.60)	(28.18)	(22.78)	(23.03)	(22.54)	(18.26)	(27.43)	(23.66)	(21.86)	(21.40)
Hotel Manager	29	40	32	40.38	41	37	51	41	45	48
	(19.31)	(26.35)	(23.36)	(28.47)	(25.39)	(18.59)	(27.17)	(21.43)	(20.59)	(21.35)
Conventional Occupations	***33***	***46***	***34***	***39***	***42***	***34***	***43***	***37***	***47***	***46***
	(19.66)	***(25.14)***	***(23.91)***	***(26.35)***	***(26.88)***	***(17.96)***	***(23.58)***	***(20.10)***	***(23.67)***	***(22.93)***
Accountant	45	40	40	42.34	47	36	35	36	48	48
	(23.44)	(20.93)	(24.35)	(25.29)	(22.60)	(16.43)	(18.79)	(17.87)	(21.36)	(21.44)
Bank Manager	35	46	36	41.22	42	39	45	41	48	49
	(19.67)	22.43)	(23.62)	(24.98)	(23.84)	(19.37)	(23.17)	(20.89)	(20.99)	(22.15)
Cashier	18	50	24	36.87	41	19	48	24	44	43
	(16.41)	(29.09)	(23.45)	(30.21)	(46.48)	(12.24)	(31.47)	(18.74)	(31.38)	(27.29)
Credit Manager	32	39	37	36.01	39	35	40	38	44	46
	(19.32)	(23.37)	(24.08)	(23.79)	(21.80)	(18.47)	(21.62)	(18.70)	(21.00)	(20.06)
Secretary	27	50	32	38.23	43	30	43	32	48	45
	(17.51)	(28.63)	(22.88)	(24.56)	(24.01)	(19.67)	(23.69)	(19.99)	(26.85)	(25.78)
Financial Analyst	48	44	46	44.22	45	44	37	48	46	46
	(24.67)	(22.77)	(28.42)	(27.42)	(23.17)	(22.12)	(19.31)	(25.59)	(21.85)	(20.89)
Bank Teller	23	51	25	37.36	40	38	51	40	47	47
	(16.58)	(28.75)	(20.60)	(28.19)	(26.29)	(17.41)	(26.96)	(18.91)	(22.25)	(22.92)

Note. INFO = Information Load, INTER = Interpersonal Load, CHA = Change Load, ACT = Activity Structure, TIME = Time Structure. Standard deviations are in parentheses.

Table 2

Slopes and Correlations of Salary and Educational Level Regressed on Magnitude Estimated Values of Five Load Types

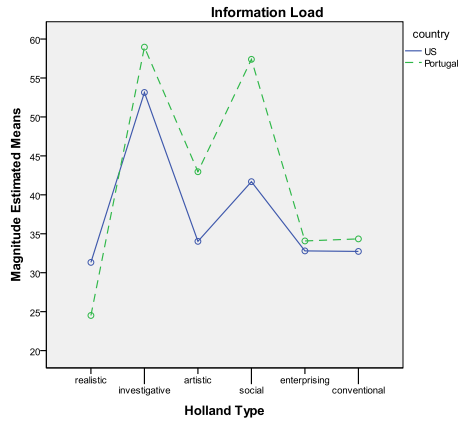
	Salary		Education	
Load Type	$	*r*	%	*r*
Information Load	2141	.765	2.14	.698
Interpersonal Load	615	.246	1.16	.423
Change Load	1832	.572	2.42	.688
Activity Structure	3333	.491	3.46	.464
Time Structure	4171	.713	3.65	.568

Note. Salary = annual salary; Education = percentage of college graduates in an occupation.

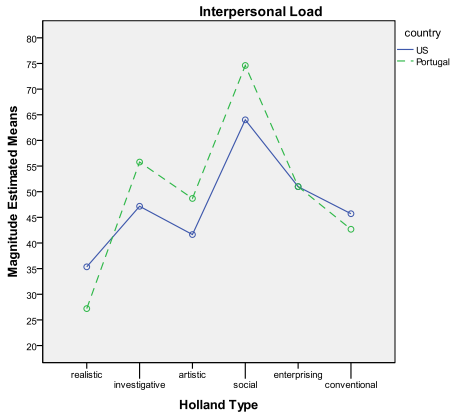
All correlations are significant at $p < .01$.

Figure 1. Load profiles of American and Portuguese respondents by Holland type.

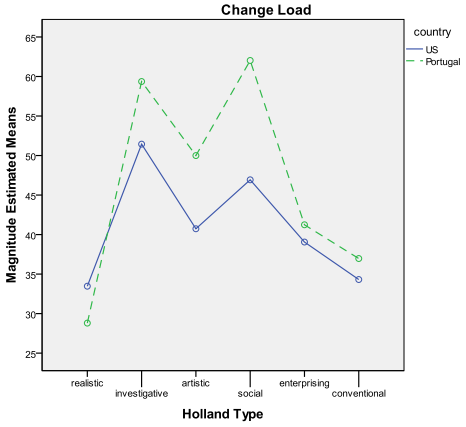
(a)



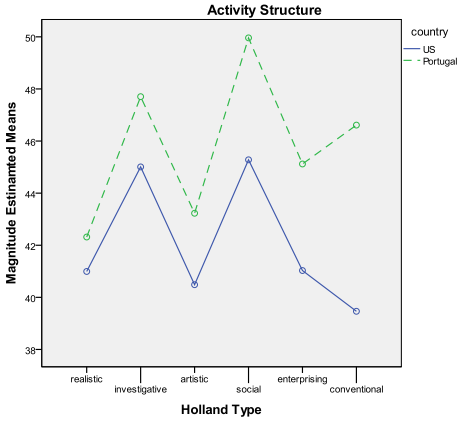
(b)



(c)



(d)



(e)