SYSTAT Application Notes

Statistical Methods In Psychological Research Using SYSTAT

Introduction

The impetus of psychological research is the inability of psychologists to accommodate new phenomena or problems with their existing knowledge. Conducting research is a formal and systematic exercise for the following reasons. First, conceptual skills are deployed to propose a theory for the to-be-explained phenomenon. Second, deductive logic is used to derive the research hypotheses from the theory. This is possible only if the theory is sufficiently specific. Third, researchers collect data systematically according to a plan or design.

Fourth, the inductive rule that underlies the experimental design makes it possible to exclude some potential interpretations of the data. Fifth, appropriate statistical procedures are used to tabulate and analyze the data. Lastly, deductive logic is used to draw the theoretical conclusion. In short, the success of the research process depends on a confluence of conceptual, meta-theoretical, methodological, and statistical skills (Chow (2002)).

Design of Experiments

Psychological researchers have long understood the importance of carefully designed experiments and have been using them. SYSTAT offers three methods for generating experimental designs: Classic DOE, the DOE Wizard and the DESIGN command. Classic DOE provides a standard dialog interface for generating the most popular complete (full) and incomplete (fractional) factorial designs. Complete factorial designs can have two or three levels of each factor, with two-level designs limited to two to seven factors, and three-level designs limited to two to five factors.

Incomplete designs include: Latin square designs with 3 to 12 levels per factor; selected two-level designs with 3 to 11 factors and from 4 to 128 runs; 13 of the most popular Taguchi designs; all of the Plackett and Burman two-level designs with 4 to 100 runs; the 6 three-, five-, and seven-level designs described by Plackett and Burman; and the set of 10 three-level designs described by Box and Behnken in both their blocked and unblocked versions. In addition, the Lattice, Centroid, Axial, and Screening mixture designs can be generated.

The DOE Wizard provides an alternative interface consisting of a series of questions designing the structure of the design. The wizard offers more designs than Classic DOE, including response surface and optimal designs.

Optimization methods include the Fedorov, k-exchance, and coordinate exchange algorithms with three optimally criteria available. The coordinate exchange algorithms accommodate both continuous and categorical variables. The search algorithms for fractional factorial designs allow any number of levels for any factor and search for orthogonal, incomplete blocks if requested. The DESIGN command generates all designs found in Classic DOE using SYSTAT's command language.

Power Analysis

The question of sample size is a technical consideration comprising one aspect of the general problem of design. Although, in general terms, it is difficult to specify how many subjects are required to make a clinical trial worthwhile, to embark on any study without considering the sample sue which is adequate is unwise, and may even be unethical. It is important to realize, right from the start, that sample size calculations will always be approximated. It is clearly impossible to predict the exact outcome of any particular clinical trial or laboratory experiment.

Nevertheless, the importance of sample size calculations is demonstrated by the fact that they provide information about two important design questions:

- How many subjects should participate in the intended experiment?

- Is this study worth doing if only n subject (a fixed number) participate?

For a specific experimental design, SYSTAT's power analysis (POWER) explores the relationship between sample size and the probability of achieving statistical significance. Available experimental designs include:

- comparing a single proportion to a value
- equality of two independent proportions
- comparing a correlation coefficient to a value
- equality of two correlation coefficients
- z-tests (one sample and two sample)
- t-tests (one sample, paired and two sample)
- one-way ANOVA
- two-way ANOVA

Power calculations for other designs can be performed using generic power analysis. In this case, specify the degrees of freedom and the non-centrality parameter to perform the analysis. This approach can be used for general factorial designs, randomized block designs, and fixed effect regression, as well as many other designs.

In general, power depends on the parameters of the population(s) involved, the probability of making an error, and the size of the sample(s). For a fixed error rate and set of population parameters, you can either find the sample size needed to achieve a specific power level or find the power corresponding to a specific sample size. You can also find the power for each sample in a range of sample sizes.

Applications

Spontaneous awakenings from sleep were studied in a group of 21 elderly subjects (mean age 69.29 +/- 3.02 years) free of neurological and somatic diseases. The prevalence of awakenings and the duration of waking bouts were analyzed with regard to the prior sleep state (Salzarulo et al. (1999)).

The results showed an increased frequency of awakenings during Stage 2 NREM in the elderly, who wake out of Stage 2 NREM no less frequently than out of REM sleep.

This trend is different from that observed in younger subjects (babies and young adults), where a clear prevalence of REM sleep awakenings has been reported. The duration of Stage 2 interrupted by awakening was shorter than Stage 2 followed by sleep. The duration of waking bouts did not differ according to the preceding sleep stage.

It is suggested that the relative inability to sustain Stage 2 may be a mechanism, which contributes to the difficulty of sleep maintenance in the elderly. Data analysis was carried out using Friedman two-way analysis of variance by ranks in SYSTAT.

Few investigations have looked at behavioral stress outcomes in Alzheimer's caregivers. The study by Burns et al. (2002) documented concentration deficits to examine behavioral outcomes of stress in 33 Alzheimer's Disease (AD) caregivers and in 33 age-, sex-, and race-matched controls.

Paired t-tests were used to compare caregiver-control mean differences on individual measures such as time (in seconds) spent solving problems on the EFT and the Perceived Stress Scale. Hotelling's T^2 was used to compare caregiver control mean differences on the three SCL-90R global indices.

Although a Bonferroni-adjusted test was used to assess mean differences on an individual index, the current experiment reports the F statistic and p value associated with the univariate test. A single-degree-of freedom F test was used to compare the mean of one EFT group with the mean of remaining EFT participants. Pearson's correlation coefficient was used to assess the association between behavioral stress outcomes among caregivers.

All data were analyzed using SYSTAT The results depicted that caregivers showed less persistence than controls in solving problems from a standard test of problem-solving ability.

In addition, caregivers tended to make more errors than controls on a standard proofreading task ($p < .09$). In AD caregivers, cognitive deficits (represented by lower scores on problem-solving and concentration tasks) may be representative of a broader deficit in concentration that impairs the ability of caregivers to provide for their own needs and the needs of the family member for whom they are caring.

In order to test the different expectations of evolutionary psychologists and "folk" psychologists about whether men or women are better at judging family resemblance, Nesse et al. (1990) created a test consisting of pairs of photographs, some of a parent and that parent's child, and some of an unrelated parent and child. Two hundred subjects judged the relatedness of 24 pairs of photos.

A three-way nested analysis of variance (ANOVA) was performed on the number of items correct using the multi-linear general linear hypothesis module using SYSTAT, with a between subjects variable of sex of rater and within-subjects variables of sex of parent and sex of child in the photographs. The results show women and men to be equal in ability to judge family resemblance (mean number correct 14.99 versus 14.53, $F = 1.7$, $p = 0.19$).

Both sexes were better able to judge resemblance for mothers than fathers ($F = 11.25$, $p < 0.0001$), and men and women were better at judging relatedness for children of their own sex ($F = 3.99$, $p < 0.05$). Ability to judge family resemblance was not related to the rater's age, marital status, number of siblings, number of children, or years of education.

On a test of ability to recall faces, women were superior ($F = 4.14$, $p < 0.043$). These findings are considered in relationship to previous research and to the predictions of evolutionary and folk psychology. The Mohawks of Kahnawake are in the midst of a real life experiment in revitalizing their language.

An educational psychology study by Hoover et al. (1992) to determine the current state of the language, Kahnawake residents completed a detailed questionnaire about the Mohawk skills of family members, about their own use of the language and their attitudes towards the language.

The analyses with SYSTAT consist of a factor analysis to determine the underlying patterns of responding, and a multivariate analysis of variance using the General Linear Model function of the changes in these patterns over the different age groups. Results indicate that efforts to teach the younger generation to speak Mohawk have been successful.

Compton et al. (2002) collected survey data about computer knowledge, interest and level of interest from 478 students at three types of colleges - a four-year liberal arts college, a business college and a community college to predict the impact of computer attitudes on computer knowledge, which is still a key component to the understanding of information sciences.

The participants included individuals who fell within three self-rated computer knowledge categories, novice ($n = 46$), average ($n = 286$), or expert ($n = 146$), Stepwise discriminant function analysis using SYSTAT was used to find the best subset of surveyed characteristics with which to discriminate among respondents with novice, average, or expert levels of computer knowledge.

Two composite measures extracted from a previous analysis, reinforcement expectations for computers, and efficacy expectations for computers, and the statement, "I know how to use computer programs:' were significant predictors of computer competency.

Conversely, traditionally examined demographic variables such as gender and age were not significant predictors. It is well known that bilinguals perform better in their first language (L1) than in their second language (L2) in a wide range of linguistic tasks.

Segalowitz and de Almeida (2002) investigated the reasons for this "L2-better-than-L1" effect. English French bilinguals performed one word relatedness and two categorization tasks with verbs of motion (e.g., run) and psychological verbs (e.g., admire) in both languages.

In the word relatedness task, participants judged how closely related pairs of verbs from both categories were. In a speeded semantic categorization task, participants classified the verbs according to their semantic category (psychological or motion). In an arbitrary classification task, participants had to learn how verbs had been assigned to two arbitrary categories.

The analyses were run in SYSTAT using Kruskal multidimensional scaling. Participants performed better in L1 in the semantic classification task but paradoxically better in L2 in the arbitrary classification task. To account for these effects, the authors used the ratings from the word relatedness task to plot three dimensional "semantic fields" for the verbs.

Cross language field differences were found to be significantly related to the paradoxical performance and to fluency levels. The results have implications for understanding of how bilinguals represent verbs in the mental lexicon. A study by Blais (2002) adapts Lazarus and Folkman's 1984 model of stress and coping to describe individual decision processes.

The research also investigates the role of situational and person factors in coping and choice processes. In the first phase of the experiment, participants described two stressful decisions they were facing (i.e., a romantic decision and a school related decision) and completed personality and cognitive style inventories as well as measures of threat, challenge, and self-efficacy appraisals.

Three weeks later, the same participants reported how they had dealt with their decisions.

They also completed the appraisal measures and described the choice options they would prefer (or had chosen). Results of structural equation modeling (RAMONA) using SYSTAT reveal that appraisals of self-efficacy influence coping patterns.

Furthermore, individual difference measures of positive affect and fear of invalidity were indirectly related to coping via self-efficacy appraisals, and coping patterns and self-efficacy appraisals predicted aspects of the choice.

Differences in decision domains qualified some of the relationships among constructs. Overall, the findings show that theories of stress and coping add insight to choices and their surrounding experiences.

Conclusions

The description above just gave a bird's eye view of SYSTAT's capabilities. But SYSTAT provides a powerful statistical and graphical analysis system in a graphical environment using descriptive menus and simple dialog boxes.

SYSTAT's command language provides functionality not available in the dialog box interface in addition to complete coverage of menu-based functionality. Robust algorithms from leading statisticians give meaningful results-even with extreme data.

Create compelling reports by combining formatted statistical output with publication-quality graphs in SYSTAT's rich text output window.

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