IFPress.com NEWSLETTER

Winter 2021 • Issue 24(3)

Incomplete block rotations... (pgs. 3 & 4)

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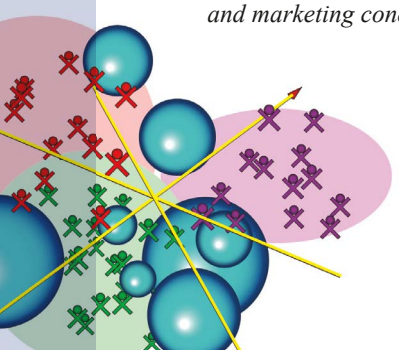
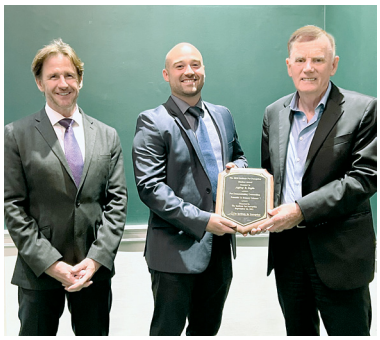
The Institute for Perception

The Institute for Perception, founded in 1992, is a full-service research consulting firm offering comprehensive client services to assist in the development process of new and improved products and marketing concepts.



President's Message

2021 Review, 2022 Preview



During our November program at The Greenbrier, I had the pleasure of presenting our 2020 Student Award to the winner, **Jeff Inglis**. We congratulate him and encourage any qualifying senior undergraduate or graduate student to apply for the 2021 Award. Applications will be accepted through January 22, 2022.

In this issue's technical report, we consider rotations for incomplete block designs. These designs occur when respondents in a sequential monadic test, such as a category appraisal, evaluate a sub-sample of the products tested. In previous technical reports we showed how to develop rotations for sequential monadic tests in which product positions, product sequences, and sequence spread were selected to create highly balanced experiments. These were for complete designs. Incomplete designs pose special challenges, and we approach their resolution by adapting an existing technique designed for tests that involve multiple days. When used in practice, this approach yields very satisfactory designs that will reduce bias and variance.

We have two courses planned for the spring of 2022. On April 5-8, we will teach a course on **Difference Testing and R Training** at The Greenbrier and it will also be offered via Zoom (see details on pages 5-7). Then in May, our annual Ad Claims course, **Advertising Claims Support:** *Case Histories and Principles*, will be presented via Zoom on May 23-26. I hope to see you in the spring, in person or virtually, for these great sensory and consumer science learning opportunities.

Best regards,
Daniel M. Ennis
President, The Institute for Perception

WHAT WE DO:

- **Client Services:** Provide full-service product and concept testing for product development, market research, and claims support
- **Education:** Conduct internal training, external courses, and online webinars on product testing, advanced analytics, and advertising claims support
- ***IFPrograms®*:** License proprietary software to provide access to new modeling tools
- **Research:** Conduct and publish basic research on human perception in the areas of methodology, measurement, modeling, and prediction

WEBINAR CALENDAR:

March 17, 2022 ..... Thursday at 2:00 PM EST, 75 minutes
- **Tools for Sequential Test Rotations**

EVENT CALENDAR:

>>>>>>>>>> **SAVE-THESE-DATES** <<<<<<<<<<

April 5 - 8, 2022.....presented at The Greenbrier and via **Zoom**
- **Difference Testing and R Training**

May 23 - 26, 2022.....Virtual course via **Zoom**
- **Advertising Claims Support:** *Case Histories and Principles*

Detailed information and registration for all courses and webinars are available at www.ifpress.com

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WEBINAR: March 17th at 2:00 ET

Tools for Sequential Test Rotations

Taught by: **Dr. Benoît Rousseau and Dr. Daniel M. Ennis**

Sequence effects introduce bias in product testing. If not properly balanced, this bias can cause product means to be inaccurate and product comparisons to be misleading.

In this webinar, we first discuss complete block designs and then extend our overview to more complex situations including multiple-day research and incomplete block designs. Examples from actual consumer investigations will be used to illustrate how ratings for the same product can vary up to a full rating scale unit depending on its position in the design or the nature of the sample that precedes it.

We continue by focusing on three rotation generation approaches: Order randomization within a subject, William Square designs, and the column randomization and search method (CR&S). We compare these methods and show how CR&S is best equipped to minimize position, sequences, and sequence position biases.

This webinar is intended for a general audience of sensory professionals, market researchers, and product developers.

Attendance only ($269) **Recording only ($289)** **Attendance & Recording ($359)**

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Sensory Difference Tests
- Replicated Preference Testing to Diagnose Consumer Segmentation
- Introduction to Thurstonian Modeling – 1 & 2
- Advances in Tetrad Testing
- Precision of Measurement in Sensory Difference Testing
- How to Calculate Consumer Relevant Risk using Sensory Difference Tests
- Preference without a Significant Sensory Difference? A Solution
- Developing Consumer Relevant Action Standards for Sensory Difference Testing
- Discrimination Testing with Batch-to-Batch Variability
- Derived Preference and Difference from Applicability Scoring
- Predicting Future Product Success: Capitalizing on Historical Consumer Data
- Developments in Discrimination Testing for Sensory Equivalence
- Sensory Discrimination Testing: Linking Internal Panelists & Consumers

Advertising Claims Support
- Supporting Numerical Superiority Claims
- Claiming Equivalence, Unsurpassed, and Superiority Simultaneously
- Issues in Supporting "Up-to" Claims
- Supporting Count-Based Sensory Advertising Claims

Drivers of Liking® and Landscape Segmentation Analysis®
- Mapping Techniques to Link Consumer & Expert Data
- Understanding the Consumer: PM vs. LSA
- Maximizing Consumer Insights by Contrasting Blind and Branded Test Findings
- Predicting Future Product Success: Capitalizing on Historical Consumer Data

Combinatorial Tools
- Hiding in Plain Sight: Finding New Opportunities using Graph Theory
- Introduction to Graph Theoretic Tools
- Introduction to TURF
- eTURF 2.0: A Cutting Edge TURF Solution for Datasets of All Sizes
- Large TURF Problems: Finding Custom Solutions

Design Issues in Product Tests and Surveys
- The Science of Answering Questions
- Developments in Applicability & CATA Scoring
- Removing Experimental Biases in Sensory and Consumer Research Data

Innovation
- Invention and Innovation

Machine Learning
- A Three-Step Approach to Characterizing Consumer Segmentation via Machine Learning
- Action Standards for Machines and Humans in Quality Assurance
- Text Analysis of Open-Ends
- Synergistic Analytics: Turbo-Charging Consumer Analytics – 1 & 2

2021 Issue 24(3)

Optimal Rotations for Incomplete Designs

Daniel M. Ennis and Benoît Rousseau

Background: Designs for sequential monadic consumer product research, whether complete or incomplete, are subject to compromise due to attrition during testing. So, no matter how perfectly balanced a design may be at the outset, the final data will inevitably reflect a deviation from perfection. In previous technical reports[1,2] we have discussed different approaches to accounting for position, sequential effects and sequence spread in sequential monadic (complete block) designs and argue for rotations that minimize the impact of these variables at the outset of testing so that their effects on bias and variance in the final analyses can be minimized. Note that minimizing these effects is essential whether one expects attrition to be an issue or not. We recommended the use of Column Randomization and Search (CR&S) to create optimal rotations and showed how this approach is superior to either within subject randomization or replicated Williams Squares[3]. CR&S is a computer intensive method that considers millions of possible designs and chooses a design that minimizes the variances in the counts of products by position, by paired sequences, and by sequence spread throughout the design. In this technical report we explore rotations for incomplete designs.

Scenario: Your consumer research on personal care products routinely involves monadic evaluations of a set of samples, each evaluated by carefully matched consumer cells of approximately 200 respondents. While this approach generates valuable information on individual products, it lacks the insights that can be uncovered using a sequential monadic design and an unfolding analytical technique such as Landscape Segmentation Analysis.®[4] To that end, you decide to experiment with a sequential monadic design for a set of 7 shampoo and conditioner bundles. For this type of project, respondents are asked to use each bundle for at least 5 days over a one-week period. A complete block approach would require that each respondent participate in 7 successive weeks, or almost 2 months. To limit participant attrition and the potential for reduced data quality that can occur in research involving extensive data collection time periods, you decide to consider a balanced incomplete block design (BIBD), with respondents evaluating 4 of the 7 bundles. You would like each bundle to be evaluated about 200 times. You plan on recruiting 378 respondents, which will result in a final sample size of 350 (assuming about an 8% attrition) with a total number of evaluations of about 200 per bundle. This number will provide the ability to study potential population segmentation and identify the category's Drivers of Liking® using techniques, such as Landscape Segmentation Analysis,® which extract richer and more accurate information using multiple sample evaluations per respondent.

Incomplete Designs: Incomplete block designs were originally developed to improve precision in situations where there is significant within-block variation that could be confounded with treatment effects. The idea behind these designs is that treatment comparisons can be made with more precision when a smaller number of the treatments are contained within each block to restrict the effect of within-block variation. These designs apply, for instance, to crop field trials when there is a difference in fertility or drainage across the block. In consumer product testing the participants form the blocks and it is sometimes desirable to limit the number of products tested by each subject, especially when it can be expected that there will be large within-subject effects, manifested with more products tested per person. A common misconception is that incomplete block designs will result in lower costs due to lower per subject incentives. In fact, the overall sample size will need to be increased, which will increase recruitment costs, to maintain the same number of evaluations per product as a complete block design. This is necessary to ensure sufficient power in treatment comparisons. Consequently, cost savings, if any, will be minimal, and we generally recommend a complete block design when possible.

Like complete block designs, incomplete block designs are subject to imbalances and pose special challenges in creating rotations that account for position, sequence, and sequence spread. In agricultural experiments, sequential order does not occur as it does in consumer research, therefore published designs of the method[5] do not account for it. The flexibility of the CR&S method is particularly valuable in helping to reduce bias and variance in study designs for consumer testing.

In our previous technical report[2], we discussed the situation that arises when sequences are only important within a day, such as in food sensory testing, and sequences from one day to the next are of no interest due to a time delay. One way of creating an incomplete design is to use the CR&S method to generate a design as if testing occurred over separate time intervals. For a particular participant, the treatments in the incomplete block are placed in the first time interval and all remaining treatments are assigned by themselves to the remaining time intervals. Although column randomization occurs over all the columns and thus includes all of the possible products, the design chosen considers only the treatments that occur in the first interval. This approach removes the remaining treatment sequences from consideration. This method will provide a design for the incomplete blocks optimized over position, sequence and sequence spread within the incomplete portion of the total product set.

	1st Bundle	2nd Bundle	3rd Bundle	4th Bundle
Cons 1	C	E	F	G
Cons 2	A	D	G	F
Cons 3	G	A	B	E
Cons 4	F	B	A	C
Cons 5	D	G	C	B
Cons 6	E	C	D	A
Cons 7	B	F	E	D

Figure 1. Balanced incomplete block design for 7 consumers evaluating 4 of 7 samples.

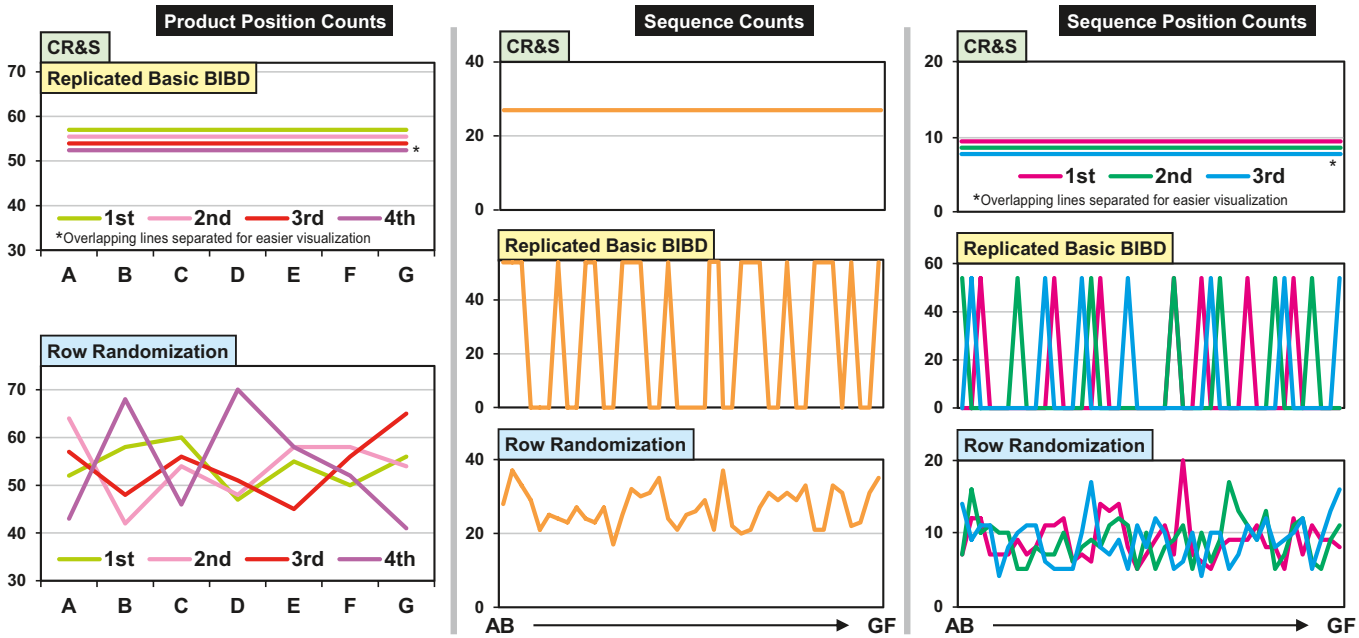


Figure 2. Product position, sequences, and sequence position counts for three incomplete design generation methods.

Incomplete Block Design Considerations: You must decide how to design your sample presentation rotations to minimize bias and variance associated with positions, sequences, and sequence positions across the incomplete design. You are aware of the CR&S method which minimizes those biases when considering a complete block design. However, you will need to adapt this method when the design is incomplete. Cochran & Cox[5] provide a series of BIBDs on various subsets of a given number of treatments. You find the basic design for 4 out of 7 treatments. Each treatment appears four times overall and appears with each other treatment the same number of times (2). This design does not account for position effects without rearrangement. Figure 1 shows a rearrangement to account for position (but not sequences) across the basic design. A balanced position arrangement may not be feasible for other designs. You could use this basic design and repeat it 54 times to obtain your full set of rotations (before attrition). However, this would not ensure the balance of sequences and sequence spread, although it would balance for product positions.

Creating the Bundle Design: For comparison, you first replicate the design in Figure 1 a total of 54 times leading to 378 rows. Figure 2 shows the frequencies with which the sequences occur. This basic design does very poorly in terms of addressing sequences and sequence spread which is important because you will not have a buffer evaluation period with a neutral sample to reduce the carryover effect of one bundle to another. This is analogous to replicating a Williams Square in a complete block design.[3] Another approach you consider is to randomize each row of the 378 × 4 matrix, with the hope that it will generate a more balanced solution. Although you lose position balance the sequence counts are more even, but this design is clearly not optimal either as seen in Figure 2. To generate a balanced design using the CR&S method, some experimentation reveals that your final design must contain a multiple of 42 blocks. Starting with 378 participants, which is a multiple of 42, you can begin your data collection with perfect position, sequence, and sequence balance as shown in Figure 2. With a rate of 8% random dropouts, you will end with a sample close to 350 and close to ideal balance.

Conclusion: Incomplete designs for consumer testing are subject to the effects of position and sequences in a manner similar to complete designs. However, they are also more complicated to ensure that these effects do not compromise results due to bias and increased variance. The CR&S method may be valuable to design incomplete block experiments by treating their design as part of a complete block experiment in which positions within only a portion of the design are of interest to control for position, sequence and sequence spread effects. Software to choose these designs is available in ***IFPrograms***®.[6]

References

1. Ennis, D. M., Rousseau, B, and Ennis, J. M. (2014). Rotations in product tests and surveys. *IFPress*, **17**(1) 3-4.
2. Rousseau, B. and Ennis, D. M. (2021). Generating optimal sample presentation orders. *IFPress*, **24**(1) 3-4.
3. Williams, E. J. (1949). Experimental designs balanced for the estimation of residual effects of treatments. *Australian Journal of Scientific Research,* Ser. A 2, 149-168.
4. Ennis, D. M. and Rousseau, B. (Eds.) (2020). *Tools and Applications of Sensory and Consumer Science*, Parts 4 & 5, pp. 72-117. Richmond, VA: The Institute for Perception.
5. Cochran & Cox (1992). *Experimental Designs.* New York: Wiley.
6. *IFPrograms*® software, Tools version, The Institute for Perception, Richmond, VA.

Difference Testing and R Training

Taught by Dr. Daniel Ennis, Dr. Benoît Rousseau, and William J. Russ

April 5 - 8, 2022

We begin our training program with a special day devoted to the open-source software, R. Due to the extensive capability of the software, made possible by contributions of many open users, R scripting and programming has become an essential tool in data analysis and reporting. We will explain what R is, data structures used in R, how the software can help you compute simple and advanced analyses, how to engage with the numerous graphic tools available in R, and how to interface the software to external tools such as Excel and PowerPoint.

On Wednesday, we will focus on the science of measuring sensory differences. The standard approach to investigating whether sensory differences exist or not is to use appropriately powered discrimination tests and rely on the *p*-value from a null hypothesis of no-difference. While this might be a suitable approach when trying to demonstrate that a sensory difference exists, it lacks a philosophical and statistical foundation when research needs to establish a sensory "match." In this course, we will depart from this tradition and describe a more reliable approach supported by decades of research using the Thurstonian modeling framework and a consumer relevant action standard.

Using a scenario that begins with a proposed formulation change, we follow the project's path starting with the application of Thurstonian theory to resolve conflicting difference test results. We then describe a typical power approach to a risk-management program involving the tetrad method, optimal panel sample sizes, and a consumer-relevant internal action standard. The internal action standard is based on consumer research. We proceed by outlining limitations of the traditional approach to study equivalence and describe a more reliable direct test using the same action standard. The takeaway from the course is that participants will be able to generate superior recommendations for optimal panel sample sizes based on a company's preferred risk profile. Attendees will participate actively in the journey outlined in this course through a series of exercises and the use of the *IFPrograms*® software.

TUESDAY

April 5, 9am - 5pm ET

- **Welcome and introductions**
- **Introduction to R**
  - R and RStudio®
  - How to write scripts
  - Useful commands
  - Functions for statistical analyses
  - Packages and libraries
- **Data Analysis**
  - Importing data (Including CSV, XLSX, SPSS, SAV, etc.)
  - Data wrangling, cleaning, and manipulation
- **Scripting and Project Managment**
  - Writing custom functions
  - Data Structures
  - Visualization
  - Data export
- **Project Organization and Managing Workflow**
  - Git and GitHub (version control)

WEDNESDAY

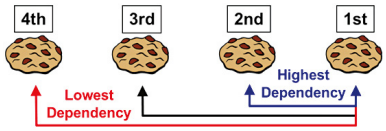
April 6, 9am - 5pm ET

- **Introduction to Difference Testing**
  - Methodological and analytical review of sensory measurements
  - Overview of sensory discrimination testing
  - Background to workshop's illustrative scenarios
- **Project 1: Flavor improvement of a chocolate-based snack**
  - Introduction of the 2-AFC and 3-AFC methodologies – ***IFPrograms exercises***
  - Standard statistical approach: Binomial test and 95% confidence level
- **Project 2: Ingredient change of a baked good product – Product "match"**
  - Introduction of the duo-trio and triangle methodologies
  - Finding inconsistencies and low confidence in experiment conclusions – ***IFPrograms exercises***
- **Proportion of discriminators in the population:** Background and why it is misleading
- **Introduction of a theoretical structure for sensory measurements**
  - Illustrative examples based on peered-reviewed research
  - Expanding a purely statistical state-of-mind by incorporating decision processes – ***IFPrograms exercises***
  - Thurstonian Theory: Introduction of a standardized measure of sensory difference, δ, and of its estimate d'

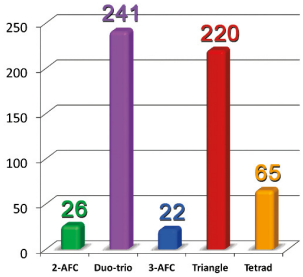
(Wednesday, Thursday, and Friday outline continues on the next page.)

WEDNESDAY *Continued...*

- **Thurstonian structure for sensory measurements**
  - Application of basic principles to intensity and hedonic rating scales
  - Application to ranking and Check-All-That-Apply (CATA) scoring
  - Estimating the size of sensory differences – ***IFPrograms exercises***



- **Back to Project 1 and Project 2**
  - Data analyses and interpretation; resolution of result inconsistencies – ***IFPrograms exercises***
- **Why a difference will always be found: The need to estimate consumer relevance**
  - Preference testing to establish importance/relevance
  - Introduction of the beta-binomial model to handle test replications
  - Application to Project 1 and Project 2 – ***IFPrograms exercises***



- **Beyond the traditional triangle and duo-trio tests: The tetrad method**
  - Illustration of the reason behind the tetrad method's superior statistical power
  - Review of published case studies confirming the tetrad's superiority
  - The importance of giving the proper task instructions
- **Case Study**: A significant consumer preference despite a lack of statistical sensory difference – ***IFPrograms exercises***

THURSDAY

April 7, 9am - 5pm ET

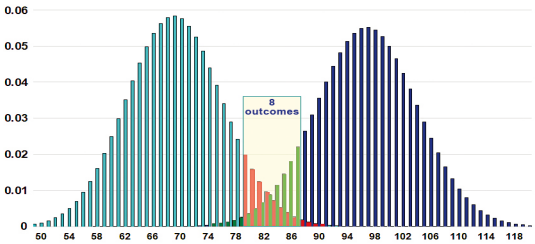
- **Next Step: The limitations of focusing solely on statistical significance**
  - Illustration of the differences in statistical power of common sensory discrimination methods – ***IFPrograms exercises***
  - The need to estimate the importance of a sensory difference: Consumer relevance and δ_R
  - Simulations and estimates of optimal sample sizes – ***IFPrograms exercises***
- **Establishing the size of a consumer relevant sensory difference: Using the same-different method**
  - Overview of the same-different method
  - Are two samples the same or different? The tau criterion
  - Application to Project 1 and Project 2 – ***IFPrograms exercises***
  - Research involving linking internal and consumer panel sensory sensitivities – ***IFPrograms exercises***
  - Building a successful sensory testing program: Type I and Type II errors, methodology, panelists, sample size, consumer relevance (δ_R)

- **Establishing the suitability of a switch to the tetrad method**
  - Review of experimental variables: Training, retasting, memory
  - Beverage research to study the switch from triangle to tetrad – ***IFPrograms exercises***

FRIDAY

April 8, 9am - 1pm ET

- **Latest developments: Difference or equivalence testing**
  - Contrasting difference and equivalence testing
  - Reframing Project 1 and Project 2 in terms of difference *(Project 1)* and equivalence *(Project 2)* testing
  - Potential issues with traditional power concept for equivalence testing: Varying sample sizes – ***IFPrograms exercises***
  - Why the concept of proportion discriminators is also misleading for equivalence testing
- **Theoretical illustrations of the switching roles of α** *(incorrectly rejecting no difference)* **and β** *(incorrectly accepting no difference)*
  - Graphical representation – ***IFPrograms exercises***



- **Practical application of difference and equivalence testing**
  - Revisiting the previous power and sample size considerations of Project 1 and Project 2
  - Why experimental parameters must by modified for equivalence testing *(Project 2)*
  - Development of a broad sensory discrimination testing program for difference and equivalence testing objectives – ***IFPrograms exercises***
- **Review of all covered materials and workshop conclusions**

Registration

Difference Testing and R Training

presented Tuesday, April 5 - Friday, April 8, 2022

	FEE
In-person attendance at The Greenbrier	**$1,575***
Live stream attendance via Zoom	**$1,175***
R Training only via Zoom or in-person	**$495**

***** *Includes complimentary R Training on the first day. For academic and multiple registration discounts, please contact us before registering.*

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Fee includes:

- Printed manuals of slides and software exercises
- A printed copy of our book, *Tools and Applications of Sensory and Consumer Science* and PDF downloads of the following 2 books: *Thurstonian Models: Categorical Decision Making in the Presence of Noise*, and *Readings in Advertising Claims Substantiation*
- Food and beverage refreshments each day, plus lunch and dinner on Tues. - Thurs. for attendees at The Greenbrier
- A 3-month free trial of ***IFPrograms®*** Professional version

Register online at www.ifpress.com/courses where payment can be made by credit card. A fee discount is available for students and multiple registrations. If you qualify for a discount or need information about payment by invoice, please contact **Susan Longest** at mail@ifpress.com or call 804-675-2980 before registering.

LOCATION: The course will be presented at The Greenbrier® in White Sulphur Springs, WV. Nestled in the Allegheny Mountains, this gracious hotel is renowned for its hospitality and service.

LODGING: Lodging is not included in the course fee and participants must make their own hotel reservations. A block of rooms is being held at The Greenbrier at a special rate of **$235** *(plus resort fees & taxes)*. To make a reservation, please call **1-877-661-0839** and mention you are attending the ***Institute for Perception*** course (***Note:*** *the special rate is not available through online reservations.)* To learn more about The Greenbrier, *America's resort since 1778*, visit their website at www.greenbrier.com.

TRANSPORTATION: The Greenbrier Valley Airport (**LWB**) in Lewisburg is only a 15 min. shuttle ride from the hotel. Direct flights to LWB are available on United Airlines from Chicago O'Hare (**ORD**) and Washington Dulles (**IAD**). Other airports include Roanoke, VA (**ROA,** 1hr. 15 min.), Charleston, WV (**CRW,** 2 hrs.), and Charlottesville, VA (**CHO,** 2 hrs. 15 min.).

CANCELLATION POLICY: Registrants who have not cancelled two working days prior to the course will be charged the entire fee. Substitutions are allowed for any reason.

The Institute for Perception

This course has been developed for technical and supervisory personnel involved in all aspects of sensory and consumer research.

THIS COURSE WILL ALSO BE PRESENTED VIA

zoom

If you are unable to attend in person, this course will also be live streamed via Zoom. If you attend virtually, you will be sent a link by email to join the meeting with the speakers and other attendees. All supporting materials will be mailed to you before the event, so please register early to allow for sufficient shipping time.

IFPrograms,® R, and RStudio® Software

The course instruction includes software to perform analyses and exercises. Prior to the course, you will be sent information by email to install R and RStudio® to be used on Tuesday, and *IFPrograms®* to be used Wednesday-Friday. To introduce you to the capabilities of *IFPrograms,®* you will also receive a complimentary 3-month trial of the Professional version used for an extensive collection of sensory and consumer data related analyses. For a detailed listing of *IFPrograms®* features and licensing, please visit www.ifpress.com/software.

(Note: IFPrograms is not required to apply course principles.)

SPEAKERS

For detailed biographical information, please visit www.ifpress.com

Dr. Daniel M. Ennis
The Institute for Perception
- President

Dr. Benoît Rousseau
The Institute for Perception
- Senior Vice President

William (Will) Russ
The Institute for Perception
- Computational Market Researcher and Lead Programmer

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