# Stated or Misstated Health Preferences? Statistical Consequences of Suboptimal Experimental Design in Conjoint Surveys

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## Objectives

- To investigate the effect of suboptimal level balance and orthogonality in experimental designs on the accuracy of preference and welfare estimates.
- To develop an adjusted model to account for problems in the experimental design.

## Introduction

The validity and precision of stated-choice or conjoint preference estimates depend critically on characteristics of the experimental design. We analyzed the effect of a flawed experimental design in an existing empirical study of patient preferences for eczema treatments by a market research firm.

Each hypothetical eczema treatment was characterized by four attributes:

1. Speed of relief and application restrictions (4 levels)
2. Likelihood of flare reduction per year (3 levels)
3. Drug plan coverage (2 levels)
4. Price per package (8 levels)

There are four factors to consider when developing a statistically optimal experimental design (Huber and Zwerina, 1995): (1) Level balance; (2) Orthogonality; (3) Minimal overlap; and (4) Utility balance.

A design that is balanced and orthogonal is necessary for efficient and unbiased estimation (Kanninen , 2002).

### The Experimental Design Is Unbalanced Among Attribute Levels

| | Speed and Application | | Flare Reduction | | Insurance Coverage | | Price | |
|---|---|---|---|---|---|---|---|---|
| Level | Design Goal* | Actual Design | Design Goal | Actual Design | Design Goal | Actual Design | Design Goal | Actual Design |
| 1 | 9 | 10 | 12 | 14 | 1 | 12 | 5 | 3 |
| 2 | 9 | 10 | 12 | 14 | 18 | 24 | 5 | 3 |
| 3 | 9 | 9 | 12 | 8 | | | 4 | 3 |
| 4 | 9 | 7 | | | | | 4 | 7 |
| 5 | | | | | | | 4 | 3 |
| 6 | | | | | | | 4 | 6 |
| 7 | | | | | | | 5 | 7 |
| 8 | | | | | | | 5 | 4 |
| Maximum Difference | 0 | 3 | 0 | 6 | 0 | 12 | 1 | 4 |

* If an attribute has 4 levels, then each level should appear 36/4=9 times.

### The Experimental Design Is Not Orthogonal

| | Average Correlation | | |
|---|---|---|---|
| Attributes | A vs. B | A vs. C | B vs. C |
| Speed and Flare Reduction | 0.55 | | 0.57 |
| Speed and Insurance | -0.64 | -0.63 | -0.58 |
| Speed and Price | | -0.51 | -0.52 |
| Flare Reduction and Insurance | -0.80 | -0.60 | -0.84 |
| Flare Reduction and Price | | | -0.60 |
| Insurance and Price | | 0.61 | 0.68 |

## Methods

- It is not possible to estimate all partworths due to correlations among attributes and alternatives.
- An adjusted conditional logit model was estimated for statistically independent combinations of attribute levels. For example, 3 days speed and application everywhere can only be estimated by flare reduction of 60%.

### Adjusted Model

$$
\begin{aligned}
V_{ij} = \; & \alpha_1 \bullet (\text{Speed 3 days \& Apply anywhere / Flare Reduction 60\%})_{ij} + \\
& \alpha_2 \bullet (\text{Speed 7 days \& Apply anywhere / Flare Reduction 60\%})_{ij} + \\
& \alpha_3 \bullet (\text{Speed 7 days \& Apply anywhere / Flare Reduction 80\%})_{ij} + \\
& \alpha_4 \bullet (\text{Speed 7 days \& Apply anywhere / Flare Reduction 0\%})_{ij} + \\
& \alpha_5 \bullet (\text{Speed 10 days \& Apply anywhere / Flare Reduction 0\%})_{ij} + \\
& \alpha_6 \bullet (\text{Speed 10 days \& Apply anywhere / Flare Reduction 80\%})_{ij} + \alpha_7 \bullet \text{Price}_{ij}
\end{aligned}
$$

## Results

The value to patient (VTP) estimates are quite different between the market research model and our adjusted model. We compared these results for VTP of a comparison treatment relative to a reference treatment.

### Profiles of Reference Treatment and Comparison Treatment

| Attributes | Reference Treatment | Comparison Treatment |
|---|---|---|
| Speed and Application | 10 days<br>Apply Anywhere | 7 days<br>Apply anywhere |
| Flare Reduction | 0% Reduction | 60% Reduction |
| Price | $55 | |

### Increased Value to Patient of Comparison Treatment Relative to Reference Treatment

Market Research Model vs. Adjusted Model

| | Market Research Model | Adjusted Model |
|---|---|---|
| Speed = 3 days<br>Apply Anywhere | 32% | NA* |
| Speed = 7 days<br>Apply Anywhere | 13% | NA |
| Speed = 7 days<br>Limited Application | -13% | -8% |
| Speed = 10 Days<br>Apply Anywhere | 0% | 0% |
| Flare Reduction = 80% | 196% | 76% |
| Flare Reduction = 60% | 120% | NA |
| Flare Reduction = 0% | 0% | 0% |

* Not Applicable: The adjusted model was not able to estimate partworths for these parameters.

- The market research study found that patients have 196% increased value for a 80% likelihood of flare reduction, whereas this reduction is only 76% according to the adjusted model.
- The market research study indicates that patients have 32% increased value for 3 day speed and apply anywhere. However, the adjusted model does not have adequate information to be able to estimate this partworth.
- Correlations in the design bias estimates of the relative importance of price relative to efficacy attributes. Thus, the market research model overstates VTP of the comparison treatment relative to the reference treatment by more than 80%.

| | Market Research Model | Adjusted Model |
|---|---|---|
| VTP Comparison Treatment Relative to Reference Treatment | 196% | 76% |

## Conclusions

- A flawed experimental design can affect the accuracy and precision of treatment preference estimates and lead to incorrect interpretations of the data.
- It was possible to re-estimate preferences from an unbalanced, correlated experimental by adjusting for flaws in the design. However, it was not possible to estimate partworths for all attribute levels.
- The market research study indicates that speed/application is about 4.5 times more important than flare reduction, while it is only 2 times as important according to the adjusted model.
- Efficient, orthogonal designs can be generated with the SAS marketing research macros (Kuhfeld 2004), other readily available software, or by direct application of well-estimated experimental-design algorithms and principles.

## References

1. Huber, J. and Zwerina, K. 1996, "The Importance of Utility Balance in Efficient Choice Designs," *Journal of Marketing Research*. 33:37-317.
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3. Kuhfeld, W.F., 2004, *Marketing Research Methods in SAS: Experimental Design, Choice, Conjoint, and Graphical Techniques*. TS-694. SAS 9.1 Edition. Accessed January 12, 2005. http://support.sas.com/techsup/technote/ts694.pdf.

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