METHOD OF SUCCESSIVE INTERVALS

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1. Core Definition and Context

The Method of Successive Intervals (MSI) is a highly refined psychometric scaling technique utilized primarily in experimental psychology and social science research for the precise measurement of subjective phenomena, such as attitudes, opinions, or perceptions. Fundamentally rooted in the work of Louis Leon Thurstone, MSI seeks to place various stimuli (e.g., opinion statements, sensory samples, or attitude objects) onto a quantifiable, unidimensional psychological continuum. Unlike simpler methods that assume equal spacing between response categories, MSI mathematically derives the scale values of both the stimuli and the category boundaries simultaneously, based on empirical judgments.

The core concept underlying the method is the principle of **equally appearing intervals**, wherein judges or respondents are tasked with sorting stimuli into a predefined set of ordered categories. Crucially, these categories are typically defined verbally or through specific sample items, such as "Strongly Disagree," "Neutral," or "Strongly Agree." The genius of MSI lies in its recognition that while these verbal labels may represent subjectively unequal distances to different raters, the resulting distribution of judgments across these categories can be analyzed using probabilistic models to reveal the objective scale locations of both the stimuli and the subjective boundary points between the categories.

The data derived from the Method of Successive Intervals allows researchers to move beyond simple ordinal data. By applying specific mathematical transformations, typically involving the standard normal cumulative distribution function (z-scores), MSI converts the observed proportions of judgments into interval scale values. This interval measurement property is crucial because it permits the use of more powerful parametric statistical analyses, allowing for meaningful comparisons of psychological distances--for instance, determining if the perceived difference between "Like" and "Love" is twice as large as the difference between "Dislike" and "Hate" in a given context.

2. Historical Origin and Thurstone's Law of Comparative Judgment

The Method of Successive Intervals is inseparable from the foundational work of **Louis Leon Thurstone**, who revolutionized psychometrics in the 1920s and 1930s. Thurstone's primary innovation was the introduction of the concept of the **discriminal process**, which posits that when a person is asked to make a judgment about a stimulus, the psychological reaction evoked is not fixed but rather fluctuates, following a normal distribution of momentary values around a true mean

scale value. This theoretical framework, captured formally in the Law of Comparative Judgment, provided the mathematical basis for all his scaling methods, including MSI.

MSI was developed as a more robust and flexible alternative to the earlier, simpler scaling methods, such as the Method of Equal-Appearing Intervals. In the Equal-Appearing Intervals method, judges were forced to assume that verbal descriptors represented equidistant steps along the continuum. However, Thurstone recognized that judges often interpret the psychological distances implied by categories differently. The Method of Successive Intervals addressed this by leveraging the distributional properties of judgments across categories, thereby deriving the category boundary locations empirically rather than assuming them *a priori*. This shift allowed for a more accurate reflection of the psychological reality of the scale.

The formalization of the MSI procedure involves solving a complex system of equations based on the observed proportions of judges who place a stimulus in a category, or in a category greater than a certain threshold. The mathematical elegance of MSI, especially its reliance on the normal ogive to model the cumulative probability of placement, firmly established it as a cornerstone of classical test theory. This development was crucial for advancing the scientific measurement of latent constructs in psychology, moving attitude measurement from purely qualitative observation to rigorous quantification.

3. Operational Procedure and Data Collection

The implementation of the Method of Successive Intervals requires a carefully structured multi-step process. The initial phase involves the selection and construction of the stimuli, which must be clearly and unambiguously worded statements or samples representing the attitude object under investigation. Following this, a set of ordered response categories must be defined, typically between five and nine, ranging from one extreme to the other (e.g., "Most Favorable" to "Least Favorable").

The data collection phase involves recruiting a large, representative sample of judges who are knowledgeable about the stimuli but are not necessarily the ultimate target population for the scale itself (though often they overlap). Each judge is presented with every stimulus item and instructed to place it into one of the predefined successive categories based on how favorable, intense, or relevant they perceive the stimulus to be. The core data generated are frequency counts: for each stimulus item, the researcher records the total number of judges who placed it into each category (e.g., Category 1, Category 2, ..., Category *k*).

These raw frequency counts are then converted into cumulative proportions. For a given stimulus, the cumulative proportion up to the boundary of Category *j* is the proportion of judges who placed that item in Category *j* or any category below it. These cumulative proportions represent the probability that a stimulus's perceived scale value falls below a specific category boundary. This

proportional data is the empirical input required for the subsequent mathematical scaling process, serving as the basis for transforming ordinal judgments into interval measures using the assumed underlying normal distribution.

4. Mathematical Foundation and Assumptions

The mathematical foundation of the Method of Successive Intervals rests on the assumptions derived from Thurstone's Case V of the Law of Comparative Judgment, though often simplified variations are used in practice. The fundamental assumption is that the discriminal process for each stimulus item, and the position of each category boundary, are distributed normally along the psychological continuum, and that the standard deviations (or discriminal dispersions) of these distributions are equal across all stimuli.

The core computational step involves transforming the cumulative proportions (P) into standardized z-scores. If Pij is the proportion of judges assigning stimulus *i* to category *j* or lower, then the goal is to find the scale value (Si) of the stimulus and the scale value (Bj) of the boundary between category *j* and *j+1* such that the difference (Bj - Si) corresponds to the z-score associated with Pij. This relationship is mathematically expressed through the inverse of the standard normal cumulative distribution function (Φ-1).

The resulting matrix of z-scores is then analyzed to solve for the unknown parameters: the scale values of the stimuli (Si) and the scale values of the category boundaries (Bj). Since the system is overdetermined (meaning there are more equations than unknowns, as each stimulus provides information about every boundary), researchers utilize least-squares methods or other iterative procedures to find the best fit solution. The derived scale values constitute a true interval scale, anchored typically at zero (or some arbitrary low point) and measured in standard deviation units of the discriminal process, often referred to as 'jnds' (just noticeable differences).

5. Relationship to Other Scaling Methods

MSI exists within a family of scaling techniques, most notably alongside the **Method of Equal-Appearing Intervals** (EAI) and the Method of Paired Comparisons. EAI, often associated with Likert-type scales, is simpler but less rigorous, as it explicitly assumes that the distance between categories is psychologically equal. MSI improves upon EAI by relaxing this restrictive assumption. While EAI requires the researcher to subjectively assign category weights (e.g., 1 to 5), MSI uses the empirical data to determine the true, often unequal, psychological width of each successive interval.

In contrast, the Method of Paired Comparisons is considered the most rigorous of the Thurstone scaling techniques. Paired Comparisons requires judges to compare every possible pair of stimuli and state which one possesses more of the underlying attribute. While highly accurate, it becomes

computationally and practically intractable when the number of stimuli is large (due to the exponential increase in pairs, N(N-1)/2). MSI serves as a highly efficient compromise, offering interval scale data while only requiring judges to make a single placement judgment for each item, making it suitable for studies involving hundreds of stimuli where paired comparison is impossible.

Furthermore, MSI differs from Guttman scaling, which focuses on identifying a cumulative, deterministic hierarchy of items, and from Rasch modeling or Item Response Theory (IRT), which are more recent approaches that focus on latent traits and item difficulty/discrimination. While IRT is now dominant, MSI remains historically significant and useful in contexts where the goal is specifically to derive the scale values of the categories themselves, providing insight into how respondents psychologically partition a continuum.

6. Key Characteristics and Advantages

Empirical Determination of Boundaries: One of the greatest advantages of MSI is that the scale locations of the category boundaries are derived empirically from the data, not arbitrarily defined by the researcher. This ensures the resulting interval scale reflects the consensus of the judges regarding the subjective distance between successive categories.
Interval Data Output: The method yields interval-level data, which is superior to the ordinal data produced by simple rating scales. This permits the calculation of means, standard deviations, and the use of powerful inferential statistics, greatly enhancing the analytical potential of the measurement instrument.
Efficiency and Practicality: Compared to the Method of Paired Comparisons, MSI is highly efficient. Judges only need to classify each item once into a category, making data collection manageable even with a large pool of stimuli, thus maximizing the practical application of Thurstone scaling principles in large-scale studies.
Handling Skewed Distributions: The underlying mathematical model handles cases where stimuli cluster unevenly along the continuum. By calculating the category boundaries relative to the distribution of judgments for all items, the method accurately accounts for situations where certain sections of the scale are used more frequently or where categories are perceived to be very narrow or very wide.

The Method of Successive Intervals provides a robust mechanism for translating complex, subjective judgments into a quantifiable, standardized metric. Its primary characteristic is the careful separation of the stimulus scale value from the scale values of the judging categories, thereby providing a comprehensive map of the psychological space being measured.

7. Limitations and Criticisms

Despite its mathematical rigor, the Method of Successive Intervals is not without its limitations,

many of which stem from its reliance on fundamental assumptions of classical scaling theory. A major criticism revolves around the **assumption of equal discriminal dispersion** (Thurstone Case V). MSI assumes that the variability (spread) of judgments around the true scale value is the same for all stimuli. If some stimuli are inherently more ambiguous or difficult to judge than others, this assumption is violated, leading to inaccurate scale values. More sophisticated scaling methods, such as those derived from Case III of Thurstone's Law or modern IRT models, relax this stringent assumption.

A second practical limitation is the complexity of the computational process. While computers have mitigated the tedious manual calculations required historically, the mathematical transformation of proportions into z-scores and the subsequent solution of the simultaneous equations require specialized knowledge and statistical software, making it less accessible than simple Likert scaling. Furthermore, MSI is sensitive to the selection of the judging group; if the judges do not represent a homogeneous population in terms of their psychological interpretation of the categories, the derived scale may not generalize effectively.

Finally, MSI, like all classical scaling methods, relies on the assumption of unidimensionality--that all stimuli are being judged based on a single, continuous psychological attribute (e.g., favorability). If the stimuli tap into multiple latent dimensions (e.g., both favorability and importance), the resulting scale values become meaningless averages that obscure the true structure of the attitudes, necessitating the use of factor analysis or multidimensional scaling techniques instead.

8. Applications

The Method of Successive Intervals has been historically critical in establishing quantitative measurement in psychology, particularly in the study of attitudes and sensation. Its primary application fields include:

Attitude Measurement: MSI was instrumental in creating early standardized scales for measuring social attitudes (e.g., towards war, religion, or social groups), providing a reliable means of quantifying complex sociological variables on an interval scale for the first time.
Psychophysics: In sensory studies, MSI is often used to scale the perceived intensity of stimuli (e.g., brightness, loudness, or taste). Judges place sensory samples into verbally defined successive categories, allowing researchers to accurately map the psychological response function to physical stimuli intensity.
Educational and Clinical Assessment: Though less common now than IRT, MSI principles have been applied in developing standardized measures in educational settings, such as scaling the perceived difficulty or clinical severity of various symptoms or behavioral observations.

In essence, any domain requiring the transformation of subjective, ordinal ranking or categorization into a precise, metric scale benefits from the rigor offered by the Method of Successive Intervals,

ensuring that statistical inferences drawn about differences between scale points are mathematically valid and psychologically meaningful.

Further Reading

Psychometrics (Wikipedia)
Louis Leon Thurstone (Wikipedia)
Thurstone, L. L. (1927). A law of comparative judgment. Psychological Review.
Scaling (Social Sciences) (Wikipedia)