LEVELS OF MEASUREMENT

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Abstract

This paper presents a conceptual overview of levels of measurement—nominal, ordinal, interval, and ratio—within the context of psychology. It focuses on defining each level and illustrating their application through relevant psychological examples. By linking abstract measurement principles to real-world psychological variables, the paper highlights how levels of measurement shape data interpretation and methodological choices. The discussion emphasizes conceptual clarity as essential for accurate understanding and effective use of psychological data.

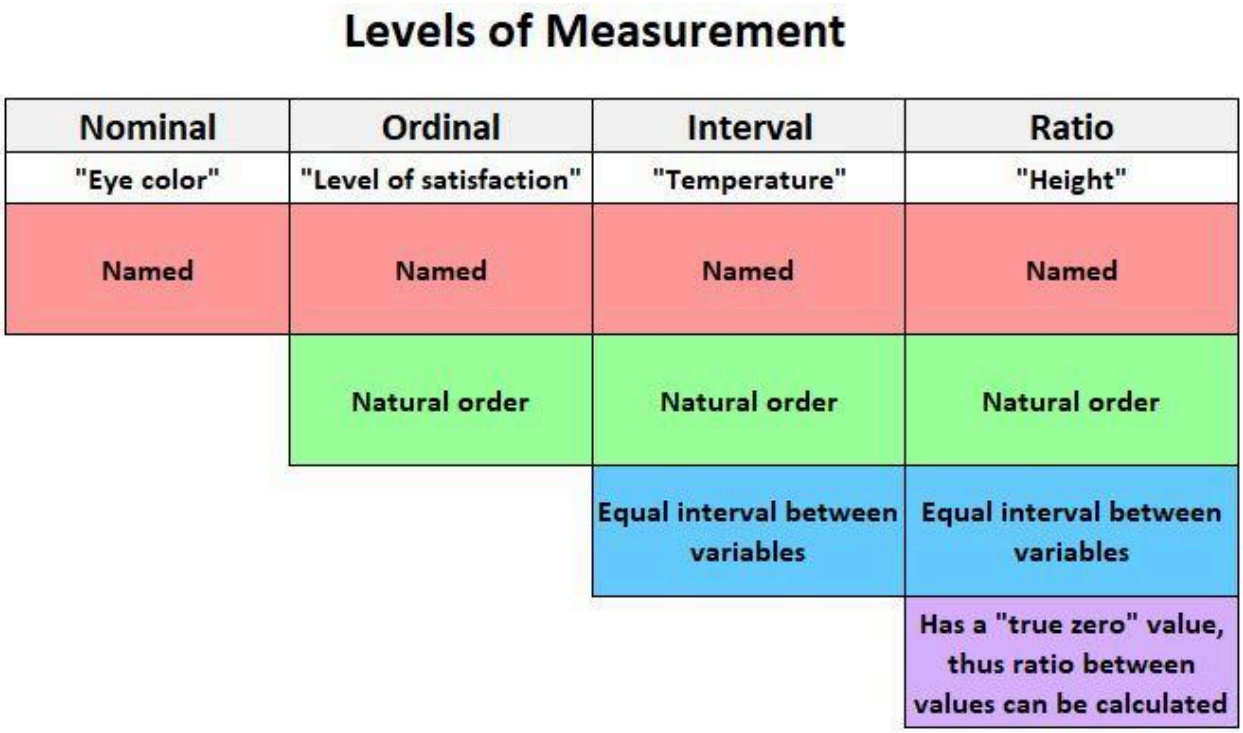
Introduction

Measurement forms the backbone of psychological research, enabling the systematic observation, classification, and quantification of human behavior and mental processes. In psychology, abstract constructs such as intelligence, personality, attitudes, and emotions must be translated into measurable forms to allow for scientific investigation. This process of assigning numbers or labels to variables is guided by the concept of *levels of measurement*, which determines how data can be organized, interpreted, and analyzed.

The framework of levels of measurement, originally proposed by Stanley Smith Stevens, classifies data into four categories: nominal, ordinal, interval, and ratio. Each level differs in terms of the properties it possesses—such as categorization, rank order, equal intervals, and the presence of a true zero point. These distinctions are not merely technical; they fundamentally shape the type of conclusions that can be drawn from data and the statistical techniques that can be appropriately applied.

In psychological research, the relevance of levels of measurement becomes particularly evident when dealing with diverse variables. For instance, diagnostic categories (e.g., types of disorders) operate at the nominal level, while constructs like socioeconomic status or severity of symptoms often fall under ordinal measurement. Psychological scales measuring intelligence or temperature-based affective states may be treated as interval, whereas variables such as reaction time or number of responses are measured at the ratio level. Thus, understanding these levels is essential for linking theoretical constructs with empirical data.

This paper focuses on the conceptual understanding of levels of measurement and illustrates each level through psychologically relevant examples. By grounding abstract measurement principles in real-world psychological contexts, it aims to enhance clarity and promote accurate application in research and practice.



1. **Nominal Level of Measurement**

Definition -The nominal level of measurement is the **simplest form of measurement**. Data at the nominal level consist of categories or groups that are used to label variables. These categories are **distinct and mutually exclusive**, and they do not imply any order or ranking among them. The only thing that matters is that the categories are correctly identified. **According to Stevens (1946), nominal data allow us to "name and classify" variables but do not allow us to perform arithmetic operations or determine the magnitude of differences between categories (Stevens,** 1946, p. 632).

Nominal scale: A scale used to label variables that have no quantitative values.
Some **examples** of variables that can be measured on a nominal scale include:

- **Gender:** Male, female
- **Eye color:** Blue, green, brown
- **Hair color:** Blonde, black, brown, grey, other
- **Blood type:** O-, O+, A-, A+, B-, B+, AB-, AB+
- **Political Preference:** Republican, Democrat, Independent
- **Place you live:** City, suburbs, rural

Properties:

- **They have no natural order.** For example, we can't arrange eye colors in order of worst to best or lowest to highest.
- **Categories are mutually exclusive.** For example, an individual can't have *both* blue and brown eyes. Similarly, an individual can't live *both* in the city and in a rural area.
- **The only number we can calculate for these variables are *counts*.** For example, we can count how many individuals have blonde hair, how many have black hair, how many have brown hair, etc.
- **The only measure of central tendency we can calculate for these variables is *the mode*.** The mode tells us which category had the most counts. For example, we could find which eye color occurred most frequently.

The most common way that nominal scale data is collected is through a survey. For example, a researcher might survey 100 people and ask each of them what type of place they live in.

Question: What type of area do you live in? **Possible Answers:** City, Suburbs, Rural.

Using this data, the researcher can find out how many people live in each area, as well as which area is the most common to live in.

Examples in Psychology:

1. **Gender:** Gender is a nominal variable, with categories such as male, female, and non-binary. These categories label individuals but do not convey a ranking or order.
2. **Psychiatric Diagnosis**: Psychiatric conditions like schizophrenia, depression, or anxiety are classified as nominal variables. They represent different mental health disorders, but there is no inherent order of severity between them.
3. **Types of Therapy**: Different therapeutic approaches (e.g., cognitive-behavioral therapy, psychoanalysis, group therapy) are nominal variables. While some therapies may be more effective for certain individuals, there is no inherent ranking of effectiveness.
4. **Personality Types:** Variables such as introversion or extraversion are nominal categories that label personality traits without suggesting a hierarchical order.

Statistical Methods for Nominal Data:

When dealing with nominal data, the most common statistical method is to determine the **mode,** which identifies the most frequently occurring category. **Chi-square tests** can also be used to examine relationships between **categorical variables.**

Implications for Research:

Nominal data are crucial for categorizing and labeling variables, but they do not provide any information about the magnitude or direction of differences between categories. Therefore, analyses that rely on means, medians, or other continuous measures are not applicable to nominal data. Researchers must choose appropriate statistical methods, like the chi-square test, which is suitable for examining associations between categorical variables.

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2**. Ordinal Level of Measurement**

Definition

The ordinal level of measurement involves data that can be ordered or ranked, but the distances between ranks are not necessarily equal. Ordinal data have a meaningful order, where categories

are ranked in a specific sequence, but the intervals between adjacent ranks are not necessarily uniform. **Stevens (1946) described ordinal data as having "relative rank" among categories, without equal spacing (Stevens, 1946, p. 634).**

Ordinal scale: A scale used to label variables that have a natural *order*, but no quantifiable difference between values.

Some **examples of variables t**hat can be measured on an ordinal scale include:

- **Satisfaction:** Very unsatisfied, unsatisfied, neutral, satisfied, very satisfied
- **Socioeconomic status:** Low income, medium income, high income
- **Workplace status**: Entry Analyst, Analyst I, Analyst II, Lead Analyst
- **Degree of pain**: Small amount of pain, medium amount of pain, high amount of pain

Variables that can be measured on an ordinal scale have the following **properties:**

- They have a natural order. For example, “very satisfied” is better than “satisfied,” which is better than “neutral,” etc.
- The difference between values can’t be evaluated. For example, we can’t exactly say that the difference between “very satisfied and “satisfied” is the same as the difference between “satisfied” and “neutral.”
- The two measures of central tendency we can calculate for these variables are ***the mode*** **and** ***the median*****.** The mode tells us which category had the most counts and the median tells us the “middle” value.
- Ordinal scale data is often collected by companies through surveys who are looking for feedback about their product or service. For example, a grocery store might survey 100 recent customers and ask them about their overall experience.

Question: How satisfied were you with your most recent visit to our store?

Possible Answers: Very unsatisfied, unsatisfied, neutral, satisfied, very satisfied.

Using this data, the grocery store can analyze the total number of responses for each category, identify which response was most common, and identify the median response.

Examples in Psychology:

1. **Pain Rating Scales:** Pain scales, such as mild, moderate, severe, and very severe, are ordinal variables. The categories are ordered, but the difference between each level is not consistently measurable.
2. **Socioeconomic Status (SES):** SES is often categorized as low, middle, and high. These categories have a rank order, but the quantitative difference in income or education level between each category is not standardized.
3. **Educational Attainment**: Educational levels (e.g., high school diploma, bachelor's degree, master's degree, doctorate) represent an ordinal scale, where higher levels indicate more education, but the steps between them are not equal in all cases.
4. **Likert Scales:** Used extensively in psychological surveys, Likert scales measure attitudes or opinions using categories like “Strongly Agree,” “Agree,” “Neutral,” “Disagree,” and “Strongly Disagree.” The order is meaningful, but the spacing between the categories is not necessarily the same.

Statistical Methods for Ordinal Data:

For ordinal data, researchers often use the **median and mode t**o describe central tendency, as these measures are not affected by the non-equal spacing of the data. **Spearman's rank-order correlation** can be used to analyze relationships between ordinal variables. The **Mann-Whitney U test** is another common method for comparing ordinal data across different groups.

Implications for Research:

Ordinal data are useful for ranking variables and understanding relative positions within a scale. However, because the intervals between ranks are not always equivalent, researchers must avoid assuming that a higher score represents a consistent increase in the attribute being measured. Analysis techniques should be chosen carefully to avoid misinterpretation of the data.

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3. **Interval Level of Measurement**

Definition and Properties:

The interval level of measurement involves data where the intervals between values are consistent and meaningful. The key characteristic of interval data is that it allows for meaningful comparisons of differences between values. However, interval data do not have a true zero point, meaning that a score of zero does not represent the absence of the property being measured. **According to Stevens (1946), interval scales have "equal intervals between points" but "no absolute zero" (Stevens, 1946, p. 636).**

Interval scale: A scale used to label variables that have a natural order and a quantifiable difference between v
but no "true zero" value.
Some **examples** of variables that can be measured on an interval scale include:

- Temperature: Measured in Fahrenheit or Celsius
- Credit Scores: Measured from 300 to 850
- SAT Scores: Measured from 400 to 1,600

Variables that can be measured on an interval scale have the following properties:

- These variables have a natural order.
- We can measure the mean, median, mode, and standard deviation of these variables.
- These variables have an exact difference between values. Recall that ordinal variables have no exact difference between variables – we don't know if the difference between "very satisfied" and "satisfied" is the same as the difference between "satisfied" and "neutral." For variables on an interval scale, though, we know that the difference between a credit score of 850 and 800 is the exact same as the difference between 800 and 750.
- These variables have no "true zero" value. For example, it's impossible to have a credit score of zero. It's also impossible to have an SAT score of zero. And for temperatures, it's

possible to have negative values (e.g. -10° F) which means there isn't a true zero value that values can't go below.

The nice thing about interval scale data is that it can be analyzed in more ways than nominal or ordinal data. For example, researchers could gather data on the credit scores of residents in a certain county and calculate the following metrics:

Examples in Psychology:

1. **Intelligence Test Scores**: IQ scores are interval data. The difference between an IQ score of 100 and 110 is equivalent to the difference between 120 and 130. However, an IQ score of zero does not mean the complete absence of intelligence.
2. **Temperature Scales**: Temperature measured in Celsius or Fahrenheit is an interval variable. The intervals between degrees are equal, but zero on these scales does not represent the absence of heat.
3. **Standardized Achievement Tests:** Tests like the SAT or GRE have scores that are interval data because the difference between scores represents a consistent amount of knowledge or skill, but zero does not indicate an absence of knowledge.

Statistical Methods for Interval Data:

Interval data allow for a wide range of statistical analyses. Measures of central tendency such as t**he mean, median, and mode** are appropriate, and **Pearson's correlation** can be used to assess relationships between variables. Advanced techniques like **t-tests and Analysis of Variance (ANOVA)** are also applicable for comparing means across groups.

Implications for Research:

Interval data enable researchers to make more nuanced distinctions between values, as the intervals are consistent and standardized. This allows for more precise comparisons and the use of more sophisticated statistical methods. However, researchers should be cautious when interpreting data points near zero, as they do not indicate an absence of the variable.

4**. Ratio Level of Measurement**

Definition and Properties:

The ratio level of measurement is the highest and most informative level. It encompasses all the properties of interval data, with the addition of a true zero point. The true zero point means that a value of zero indicates the complete absence of the measured property, and ratios between values are meaningful. **According to Stevens (1946), ratio scales have "all the characteristics of interval scales" but include an "absolute zero" (Stevens, 1946, p. 638).**

Ratio scale: A scale used to label variables that have a natural order, a quantifiable difference between values, "true zero" value.
Some **examples** of variables that can be measured on a ratio scale include:

- Height: Can be measured in centimeters, inches, feet, etc. and cannot have a value below zero.
- Weight: Can be measured in kilograms, pounds, etc. and cannot have a value below zero.
- Length: Can be measured in centimeters, inches, feet, etc. and cannot have a value below zero.

Variables that can be measured on a ratio scale have the following properties:

- These variables have a natural order.
- We can calculate the mean, median, mode, standard deviation, and a variety of other descriptive statistics for these variables.
- These variables have an exact difference between values.
- These variables have a "true zero" value. For example, length, weight, and height all have a minimum value (zero) that can't be exceeded. It's not possible for ratio variables to take on negative values. For this reason, the *ratio* between values can be calculated. For example, someone who weighs 200 lbs. can be said to weigh *two times* as much as

someone who weights 100 lbs. Likewise someone who is 6 feet tall is *1.5 times* taller than someone who is 4 feet tall.

Data that can be measured on a ratio scale can be analyzed in a variety of ways. For example, researchers could gather data about the height of individuals in a certain school and calculate the following metrics:

Examples in Psychology:

1. **Reaction Time: R**eaction time in milliseconds is a ratio variable. A reaction time of zero indicates no time elapsed, and a ratio of twice the reaction time is meaningful.
2. **Height and Weight:** These are classic examples of ratio data. Zero height or zero weight represents the complete absence of these properties, and ratios (e.g., twice as tall, half as heavy) have clear mathematical meaning.
3. **Number of Correct Responses on a Test:** The number of correct answers on a test is a ratio variable, where twice as many correct answers is exactly twice the score.
4. **Brain Activity:** Brain activity measured in terms of frequency (e.g., Hertz) or amplitude (e.g., microvolts) can be quantified as ratio data, as a value of zero indicates no activity.

Statistical Methods for Ratio Data:

Ratio data allow for all types of arithmetic operations and more complex statistical analyses. The m**ean, median, and mode are appropriate measures of central tendency, and techniques like correlation, regression analysis, and advanced statistical tests (e.g., ANOVA, t-tests) can be used for data ana**lysis.

Implications for Research:

Ratio data provide the most detailed and informative measures because they allow for precise and meaningful comparisons. Researchers can use a wide range of statistical techniques to draw conclusions and can make direct comparisons (e.g., ratios) between variables. The presence of a true zero point enhances the interpretability of the data.

Summary

The following table provides a summary of the variables in each measurement scale:

Property	**Nominal**	**Ordinal**	**Interval**	**Ratio**
Has a natural "order"	NO	YES	YES	YES
Mode can be calculated	YES	YES	YES	YES
Median can be calculated		YES	YES	YES
Mean can be calculated			YES	YES
Exact difference between values			YES	YES
Has a "true zero" value				YES

Conclusion

The four levels of measurement—nominal, ordinal, interval, and ratio—represent different ways of categorizing and quantifying variables in psychological research. Understanding the distinctions between these levels is essential for selecting the appropriate statistical methods and for drawing valid conclusions. Researchers must be aware of the properties of the data they are working with to ensure they use suitable methods for analysis. As Stevens (1946) emphasized,

each level has its own characteristics, and recognizing these differences helps researchers understand how to handle data and interpret results effectively.

References

1. Stevens, S. S. (1946). On the theory of scales of measurement. Science, 103(2684), 677–680. https://doi.org/10.1126/science.103.2684.677

2. Velleman, P. F., & Wilkinson, L. (1993). Nominal, ordinal, interval, and ratio typologies are misleading. The American Statistician, 47(1), 65–72. https://doi.org/10.2307/2684781

3. Babbie, E. R. (2020). The practice of social research (15th ed.). Cengage Learning.

4. Field, A. (2018). Discovering statistics using IBM SPSS statistics (5th ed.). SAGE Publications.

5. Trochim, W. M., & Donnelly, J. P. (2008). Research methods knowledge base (3rd ed.). Atomic Dog/Cengage Learning.

6. Gravetter, F. J., & Wallnau, L. B. (2021). Statistics for the behavioral sciences (11th ed.). Cengage Learning.