The Role Of Sensory Modality In Lexical Decision And Semantic Priming

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Introduction

Lexical decision and semantic priming are widely used methods for studying how words are recognized and how meaning becomes active in memory. In a lexical decision task, a participant decides whether a letter string or spoken item is a real word. In a semantic priming task, recognition of a target such as “nurse” is usually faster after a related prime such as “doctor” than after an unrelated prime. This difference in response time is known as a semantic priming effect and has been used to examine the organization and activation of lexical-semantic knowledge since the early work of Meyer and Schvaneveldt (1971) and Neely (1977).

The present methodology examines whether these processes operate in the same way when language is presented visually and auditorily. That comparison matters because printed and spoken words reach the language system through different perceptual routes. Visual words are available as complete letter strings, whereas spoken words unfold over time and cannot be processed all at once. Previous research has found semantic priming in both modalities while also showing differences in the timing and distribution of the effects (Holcomb & Neville, 1990). A carefully controlled design is therefore needed to separate the influence of sensory modality from the effects of word frequency, semantic relatedness, stimulus quality, and participant characteristics.

Research Aim and Hypotheses

The study was designed to investigate how sensory modality influences lexical decision performance and semantic priming. The primary comparison was between visually presented and auditorily presented words. Word frequency was included because high-frequency words are generally recognized more quickly and accurately than low-frequency words. Semantic relatedness was included because targets preceded by related primes are expected to receive faster responses than targets preceded by unrelated primes.

Three expectations guided the design. First, high-frequency words were expected to produce shorter reaction times and fewer errors than low-frequency words. Second, semantically related prime-target pairs were expected to produce a measurable priming advantage over unrelated pairs. Third, the size or timing of that advantage could differ between visual and auditory presentation because spoken-word recognition develops across time, whereas written words are normally presented as complete forms. These hypotheses concern response speed and accuracy rather than free recall; lexical decision and semantic priming are recognition and processing tasks, so describing their outcome as “lexical-semantic recall” would be imprecise.

Participants

The protocol specified a sample of 120 adults between 18 and 35 years of age, with 60 participants assigned to the visual condition and 60 to the auditory condition. Participants were recruited from a university population through convenience sampling. Eligibility required fluent English and normal or corrected-to-normal vision and hearing. People reporting neurological conditions or other conditions likely to interfere with language processing, attention, hearing, or vision were excluded according to the approved screening procedure.

Random assignment to modality was important because it reduced systematic differences between the two groups. The planned sample included an equal number of men and women in each condition, although gender was treated as descriptive information rather than a primary explanatory variable. Ethnic background was also recorded descriptively. A university convenience sample cannot be assumed to represent the wider population, so demographic balance within the sample should not be confused with full generalizability.

The sample size should be justified in relation to the smallest effect that the study aims to detect, the expected variability in reaction-time data, and the number of observations contributed by each participant. A fixed total of 120 may be adequate for some effects but insufficient for smaller interactions. Modern methodological guidance recommends reporting an explicit sample-size justification rather than relying only on a conventional number or on the sample sizes of earlier studies (Lakens, 2022).

Materials and Stimuli

The visual condition presented words on a computer monitor in black Arial type against a white background. Font size, viewing distance, screen resolution, and lighting were kept as consistent as possible so that differences in performance were not caused by avoidable changes in visual quality. The auditory condition presented the same lexical items through closed-back headphones. Recordings were produced by a fluent English speaker using a neutral speaking style and were normalized to a comfortable and consistent level.

The critical word set contained high-frequency and low-frequency English words. Frequency values should be taken from a recognized database rather than estimated informally. The English Lexicon Project provides lexical-decision and naming data for more than 40,000 words and nonwords (Balota et al., 2007), while SUBTLEX-US provides frequency estimates based on a large corpus of film and television subtitles that predict word-recognition performance better than many older norms (Brysbaert & New, 2009). Using these resources allows the researcher to document exactly how high-and low-frequency items were selected.

Stimuli also need to be controlled for variables that can influence lexical decisions independently of frequency. These include word length, orthographic neighborhood, phonological complexity, concreteness, and familiarity. The lexical-decision list must include plausible nonwords so that participants cannot respond “word” on every trial. Nonwords should resemble English spelling and sound patterns without forming actual English words. The semantic-priming list should contain related and unrelated prime-target pairs that are matched as closely as possible on target characteristics.

Visual trials were programmed in Qualtrics for basic presentation and response collection, while the auditory and time-sensitive components were delivered through E-Prime. E-Prime is designed for behavioral experiments requiring controlled stimulus presentation and millisecond-level response recording (Psychology Software Tools, Inc., n.d.). All materials were pilot-tested to identify unclear recordings, unusually difficult nonwords, obvious stimulus imbalances, or technical timing problems before the full study.

Table 1. Main variables and controls in the experimental design.

Element	Levels or Measure	Purpose
Sensory modality	Visual versus auditory	Tests whether lexical-semantic processing differs by input channel
Word frequency	High versus low	Tests the established frequency advantage in word recognition
Semantic relatedness	Related versus unrelated prime-target pairs	Measures semantic priming
Primary outcomes	Reaction time and response accuracy	Captures speed and correctness of lexical processing
Stimulus controls	Length, familiarity, neighborhood, recording quality	Reduces alternative explanations for group differences
Random factors	Participants and lexical items	Accounts for variability across people and words

Research Design

The experiment used a mixed design. Sensory modality was a between-subjects factor because each participant completed the experiment in either the visual condition or the auditory condition, not both. Word frequency and semantic relatedness were within-subjects factors because every participant responded to multiple types of words and prime-target pairs within the assigned modality. This structure reduced the risk that repeated exposure to the same items in both sensory formats would create practice, memory, or carryover effects.

Randomization was applied at two levels. Participants were randomly assigned to one of the two modality conditions, and trial order was randomized separately for each participant. Related and unrelated prime-target conditions should be counterbalanced across stimulus lists so that the same target does not repeatedly appear in both conditions for the same person. Counterbalancing helps prevent item-specific familiarity from being mistaken for a semantic priming effect.

The lexical decision task followed the standard logic described in large-scale word-recognition research: participants classified each presented item as a word or nonword as quickly and accurately as possible (Balota et al., 2007). The semantic priming task presented a prime followed by a related or unrelated target and measured whether semantic relatedness facilitated target classification. The classic finding that related words facilitate recognition provides the conceptual basis for this manipulation (Meyer & Schvaneveldt, 1971). However, priming can reflect both relatively automatic activation and strategic expectancy, depending on timing and task conditions (Neely, 1977). The stimulus-onset asynchrony and proportion of related trials should therefore be reported clearly.

Procedure

Each experimental session lasted approximately 45 minutes. After arrival, participants received an explanation of the general procedure without being given information that would encourage a particular response strategy. They then reviewed the consent form and had an opportunity to ask questions. Participants who agreed to continue completed demographic and eligibility questions before beginning the computerized tasks.

Written and verbal instructions emphasized both speed and accuracy. A short practice block allowed participants to learn the response keys and become familiar with the presentation format. Practice items were not reused in the main experiment. In the visual condition, stimuli appeared on the monitor; in the auditory condition, stimuli were delivered through headphones. Each participant remained in the assigned modality throughout the session.

During lexical-decision trials, a single word or nonword was presented and the participant pressed one key for “word” and another for “nonword.” Response time was recorded from stimulus onset to the keypress. The semantic-priming block presented a prime followed by a related or unrelated target, after which the participant made the required lexical decision. Brief pauses were provided between blocks to reduce fatigue. The earlier specification of a 2,000-millisecond presentation and a 500-millisecond interval should be applied consistently, but auditory timing also needs to account for the actual duration of each recording because spoken words unfold over time.

At the end of the session, participants were debriefed and given an opportunity to ask questions. Compensation was provided at the rate approved by the institution. Payment should reimburse time and inconvenience without becoming so large that it places inappropriate pressure on people to participate.

Data Preparation and Statistical Analysis

Accuracy and reaction time were the main dependent variables. Trials with incorrect lexical decisions should be excluded from the primary reaction-time analysis because the response time does not represent successful recognition. Extremely fast responses that are unlikely to reflect genuine processing and unusually slow responses caused by distraction or interruption should be handled according to a rule specified before examining the results. The number of removed trials and the exact exclusion criteria should be reported transparently.

Reaction times are often positively skewed, so the analysis should evaluate whether transformation or an appropriate response-time model is needed. Rather than averaging all responses for each person and item, the study can use mixed-effects models that retain trial-level data and account for variation across both participants and words. The fixed effects would include modality, frequency, semantic relatedness, and theoretically relevant interactions. Random effects for participants and items should reflect the repeated structure of the data, while remaining supported by the available observations (Barr et al., 2013).

Accuracy can be analyzed with a generalized mixed-effects model using a binomial outcome. Reaction-time and accuracy findings should be interpreted together, since faster responses accompanied by more errors may indicate a speed-accuracy trade-off rather than improved processing. Effect sizes, confidence intervals, model specifications, exclusions, and any deviations from the planned analysis should be reported alongside significance tests.

Ethical Considerations

Participation was voluntary and required informed consent. The consent process described the tasks, expected duration, compensation, foreseeable discomfort, confidentiality procedures, and the right to withdraw without penalty. Participant names and contact details should be stored separately from behavioral data, and analysis files should use anonymous identification codes. Only authorized members of the research team should have access to identifiable information.

The protocol required approval from the university's ethics review body before recruitment. The American Psychological Association's ethics code emphasizes informed consent, avoidance of harm, privacy, confidentiality, and accurate reporting in psychological research (American Psychological Association, 2017). Because the tasks involve ordinary words and simple keypress responses, the study is expected to present minimal risk, but participants may still experience fatigue, frustration, or temporary discomfort from sustained attention or headphone use. Breaks and the option to discontinue help address these risks.

Methodological Strengths and Limitations

A major strength of the design is the direct comparison of visual and auditory lexical processing using closely matched materials. Separating participants by modality avoids repeated exposure to the same target in two formats, while the within-subject manipulation of frequency and relatedness provides efficient comparisons within each modality. Pilot testing, randomized trial order, and recognized lexical databases further improve experimental control.

Several limitations remain. Convenience sampling restricts generalization beyond young university adults. Assigning modality between participants means that individual differences can add noise to the visual-auditory comparison, even with random assignment. Auditory and visual stimuli are also difficult to equate perfectly: printed words appear simultaneously, whereas spoken words have different durations and become identifiable at different points. Finally, a methods section cannot establish that one modality produces better performance until the planned data have been analyzed. The design supports a fair test of the question, but it does not predetermine the result.

Conclusion

This methodology provides a structured way to examine the role of sensory modality in lexical decision and semantic priming. It combines a between-subjects comparison of visual and auditory input with within-subject comparisons of word frequency and semantic relatedness. Reaction time and accuracy offer complementary measures of how efficiently words are recognized and how strongly related meanings facilitate processing.

The quality of the study depends on careful stimulus matching, a justified sample size, consistent timing, transparent exclusion rules, and an analysis that accounts for variability across both participants and lexical items. Ethical approval, informed consent, confidentiality, and accurate reporting are equally important. With these controls in place, the experiment can contribute useful evidence about the shared and modality-specific processes involved in recognizing words and activating meaning.

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