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This study investigated the modality effect in a leading prose recall assessment tool. Participants were 60 college-educated adults from a northeastern metropolitan area. The Logical Memory I (LM I), an immediate recall subtest of the Wechsler Memory Scale-Third Edition, was administered via auditory, visual, or combined simultaneous auditory-visual presentation. Auditory presentation resulted in superior recall of the terminal detail compared to visual presentation, but neither single-mode presentation differed significantly from combined auditory-visual presentation. The three presentation conditions resulted in comparable recall raw scores. Findings demonstrate the modality effect and indicate presentation modality does not affect the overall recall of the LM I prose passages.

THE MODALITY EFFECT AND IMMEDIATE RECALL OF LOGICAL MEMORY IN THE WECHSLER MEMORY SCALE - THIRD EDITION

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CHAPTER 1

INTRODUCTION

Memory, the ability to travel back in time mentally or to call forth past experiences, is part of what separates humans from animals (Tulving, 2002). Short-term memory in particular is responsible for many crucial cognitive functions, such as manipulating information and problem solving, temporary storage, and encoding for long-term storage (Atkinson & Shiffrin, 1971). A memory phenomenon known as the modality effect occurs when auditory presentation of information is superior to visual presentation in maximizing short-term recall in some contexts (Penney, 1989). Memory assessment tools address the modality issue differently, usually employing auditory and visual presentation for different tasks. The Wechsler Memory Scale-Third Edition (WMS-III; Wechsler, 1997a) is a leading memory instrument. Its prose recall task, Logical Memory I (LM I; Wechsler, 1997a), addresses the practical issue of memory in a meaningful context. The present study investigated the role of presentation modality and the modality effect in assessing short-term memory via the prose recall subtest of the WMS-III.

Review of the Literature

Memory

Multiple theories of memory have been posed across the centuries, initiated by the ancient philosophers and formalized by William James at the inception of psychology as a science. An early model for understanding memory is that of a dual system containing immediate, conscious (i.e., short-term) and preserved, unconscious (i.e., long-term) stores (James, 1890, as cited in Cowan, 1994). Further study of memory in the middle of the

20^{th} century led to a generally accepted model in which short-term memory is essential for cognition (Shiffrin, 1993). Many researchers have advanced this model with variations according to their own interpretation of the memory phenomena (e.g., Atkinson & Shiffrin, 1968; Baddeley & Hitch, 1974; Cowan, 1993; Crowder, 1986).

Atkinson and Shiffrin (1968) formed a comprehensive information processing model of memory using the dual-system framework. They proposed memory has two components: a short-term store and a long-term store. Stimuli from the environment are received by one or more of the senses via the sensory register. This information is then "encoded," or stored, initially and briefly in short-term memory. If rehearsed or otherwise kept active in the short-term store, the information can be copied and transferred for relatively permanent storage in the long-term store.

Short-term memory holds the central role in Atkinson and Shiffrin's (1968) model, such that "the overall memory system is best described in terms of the flow of information into and out of short-term storage and the subject's control of that flow" (p. 83). The sensory registers are merely an input mechanism and long-term memory is thought to be a passive warehouse, storing information indefinitely and providing access to it as needed by the short-term store.

Atkinson and Shiffrin (1968) also posited that the short-term store was primarily an auditory-verbal-linguistic (a-v-l) store. The a-v-l store was thought to maintain information for 15 to 30 seconds due to sensory trace and rehearsal processes. Short-term memory, therefore, is primarily auditory and is responsible for multiple tasks other than remembering. These other duties include rehearsal, encoding, retrieval, transferring information between short- and long-term stores, maintaining information in an active state while solving problems, making decisions, and directing the flow of information (Atkinson & Shiffrin, 1971).

This model of memory was elaborated upon by Baddeley and Hitch (1974), who proposed a three-component system involving an explicit modality basis for the intricacies of memory in the short-term store. They suggested the sensory mode of presentation plays a role in how information is stored and retrieved. The short-term store holds three components: the phonological loop, the visuospatial sketchpad, and the central executive.

The phonological loop controls short-term retention of verbal information, or information presented aurally (Baddeley & Hitch, 1974). A phonological store holds activated verbal stimuli, and an articulatory control process acts as a rehearsal or a re-coding mechanism. Stimuli presented via non-auditory modalities can be recoded into verbal material and stored or rehearsed by the phonological loop (Baddeley, 2001). Information stays active in the phonological store for 2 seconds unless refreshed by the articulatory control process, in which case it can remain active longer. Information can be transferred to long-term storage from the phonological loop.

On the other hand, the visuospatial sketchpad receives, rehearses and encodes visually-presented stimuli. Information held in the sketchpad decays rapidly, in mere milliseconds, or can be transferred to long-term storage. The third component, the central executive, is responsible for coordinating the efforts of the phonological loop and visuospatial sketchpad, for directing the flow of information into and out of short- and long-term memory, and for directing attention.

Subsequent investigation by Baddeley (1992, 2001) has introduced an additional dimension of short-term memory, the episodic buffer, and has demonstrated the integral function of the phonological loop in learning. The episodic buffer provides an interface capacity for the sharing of information between the phonological and visuospatial 'slave systems.' The importance of the phonological loop is noted in vocabulary acquisition, reading and conversation comprehension, and learning in other cognitive arenas. "The phonological loop probably represents an evolution of the basic speech perception and production systems to the point at which they can be used for active memory" (Baddeley, 1992, p. 559).

Other theorists agree that there is a separate auditory storage mode. Crowder (1978) maintains a theory of auditory short-term memory involving a precategorical acoustic store (PAS). According to the PAS theory, information received aurally has direct access to the memory system, which results in superior recall performance. Revisions to this theory allowed for stimuli with "auditory features" to access the PAS directly and to effect recall that is superior to visually-accessed stimuli (Crowder, 1986).

Investigations into "echoic memory" (Watkins, 1977) and verbal short-term memory (Cowan, 1994) further demonstrate the integral role of a modality specific (i.e., auditory) process involved in remembering. Echoic memory is the literal representation of several items for long enough to execute immediate recall; an echo or "trace" lasts up to 1 minute (Watkins). Tasks eliciting verbal memory phenomena (e.g., suffix effects, recency effects, and modality effects) continue to play a central role in short-term memory research (Cowan, 1993).

Authors propose the short-term memory theories presented above are erroneous (see Nairne, 2002). Some argue that verbal-specific storage hypotheses represent misunderstandings of the data (see Neath & Crowder, 1990) or are incomplete at best (see Healy & McNamara, 1996). The vast research into visual memory characteristics has certainly contributed to the understanding of short-term storage (see Lezak, 1995; Sternberg, 1975). Some researchers, however, argue for a more holistic approach to conceptualizing memory that would include multiple processors, one for information from each of the five senses (see Sulzen, 2001).

Short-term memory theory, regardless of the model, has been shaped in part by the auditory recall phenomenon of the modality effect. This phenomenon contributed specifically to the development of: the Atkinson and Shiffrin auditory-verbal-linguistic short-term store; the Baddeley and Hitch phonological loop; Crowder's precategorical acoustic store; and Watkins' echoic memory.

Modality Effect

The modality effect is a phenomenon in which auditory presentation almost always results in higher recall of terminal items than does visual presentation in short-term memory tasks (Murdock & Walker, 1969; Penney, 1989). Madigan and O'Hara (1992) credit Mary Whiton Calkins with first identifying modality effects in the late 1800s.

The modality effect is demonstrated in research utilizing word lists (Beaman & Morton, 2000), digit span tasks (Frick, 1984) and prose passages (Jakimik & Glenberg, 1990), and occurs in both serial recall (Gathercole, 1986) and free recall (Engle, Cantor, & Turner, 1989) conditions. It has been utilized in research ranging from brain topography in alcoholism (Cohen, Ji, Chorlian, Begleiter, & Porjesz, 2002), to schizophrenia and bipolar disorder (Baerwald, Tryon, & Sandford, 2001). It has been confirmed in research with children (Dempster & Rowher, 1983) and the elderly (West & Crook, 1990). The modality effect gives support to the separate streams hypothesis of information processing as proposed by Penney (1989) in her extensive review of the modality effect and short-term verbal memory.

Penney (1989) argued that "modality effects reflect the inherent structure of short-term memory and that no theory of human memory will be adequate if it does not provide a complete account of these phenomena" (p. 398). Her separate streams hypothesis of short-term memory attempts to be so complete. This model suggests there are modality-specific processing and storage systems in memory. More specifically, "the processing of auditorily and visually presented verbal items is carried out separately in short-term memory" (p. 399).

The auditory and visual streams have specific processing mechanisms, properties and capabilities and represent information in different ways (Penney, 1989). In the auditory stream, verbal information is represented automatically in both the acoustic (A) and phonological (P) codes. The sensory-based A code is created as a result of auditory presentation, and the information is stored as a result of sensory/perceptual processing. The P code is generated internally by silent articulation, and information is stored as a result of a person's transformation or enrichment of a sensory-based trace. The P code is common to both aurally and visually presented stimuli, but the A code is produced only for stimuli that are heard.

Because auditory stimuli are represented automatically in both the A and P codes, one cannot voluntarily prevent entry of an auditory item into short-term memory. The A code allows information to stay in short-term memory for up to a minute as an "echo" of the sensory input that requires no effort to maintain. "It is the persistence of the A code that boosts recall of recent auditory items relative to visual items in short-term memory tasks and thereby produces the modality effect" (Penney, 1989, p. 399).

Items presented in the visual modality, however, do not gain automatic entry to short-term memory. These stimuli are represented only in the P code and possibly in the visuospatial sketchpad (Baddeley & Hitch, 1974) and are represented for only a fraction of a second. Unlike the "echo" in the A code, maintaining information in the P code requires effort in the form of rehearsal. "Silent articulation may produce an 'auditory' code, but the code so produced (the P code) is clearly not the same code as that produced as a result of perceptual analysis of auditory input (the A code)" (Penney, 1989, p. 412). Therefore, short-term storage differs depending on the modality of input.

Mayes (1988) investigated the modality effect in a series of experiments. Superior recall for auditory presentation (visual stimuli read aloud by the participant) over visual presentation was evidenced in immediate recall tasks as well as delayed recall tasks with and without distractors. Distractors between presentation and delayed recall were 10.8 second intervals filled with silence, word vocalizations, or silent copying of words. Only the vocalization distractors interfered with recall in both auditory and visual conditions. These results demonstrate the modality effect and also appear to support the separate streams hypothesis.

As with storage, organization is a dimension along which the auditory and visual modalities differ. The auditory stream appears to be organized temporally with strong associations between items that are presented sequentially. "The A code seems to be specialized to preserve the order of items in short-term memory" (Penney, 1989, p.414). The visual stream, however, is spatially organized such that items presented simultaneously are recalled according to their spatial relation.

The separate streams hypothesis is supported by the occurrence of the modality effect as well as the recency effect, both of which may occur due to the unique properties of the auditory stream. In the recency effect, the most recently presented (i.e., terminal) item is recalled more than items occupying other serial positions. The recency effect occurs in both auditory and visual conditions and in both serial and free recall (Beaman & Morton, 2000). However, the modality effect occurs explicitly when auditory presentation leads to the superior recall of terminal items.

Both forced serial recall and free recall conditions elicit the modality effect (Beaman & Morton, 2000). Undergraduate participants were asked to recall a list of 16 words presented either aurally or visually. Upon free recall, participants' recall of terminal items was better than initial items (recency effect), and auditory presentation led to greater recall of list-ending words than did visual presentation (modality effect). However, in the forced serial recall condition, only auditory presentation led to increased recall of terminal items, especially the final list item.

Beaman and Morton (2000) also found that recall of the sequence of terminal items (i.e., words occupying positions 14, 15, and 16) played a role in eliciting the modality effect. In free recall, the terminal sequence was recalled initially upon visual presentation; thus accounting for the recency effect in the visual condition. Such recall strategy did not account for the superior recall of the terminal sequence upon auditory presentation in either free or forced serial recall conditions. These data suggest that an auditory-specific store may exist with superior short-term processing capabilities that manifest themselves via the modality effect.

Other authors have noted the temporal organization of items in recall tasks. Jakimik and Glenberg (1990) researched the modality effect in reference to the temporal distinciveness theory, which proposes the temporal order of stimuli is recalled more accurately upon auditory presentation. The authors administered a series of paragraphs, presented either aurally or visually. Critical paragraphs contained two target details followed by a "temporal anaphor." An anaphor is an expression referring to one of a set of antecedent details. The anaphor may be temporal ("the former," "the second one") or semantic ("the blue square," "the happy one"). Subjects were prompted to recall the phrase immediately preceding the anaphor.

The authors found that recall was superior with auditory presentation and that target details presented more recently (i.e., at the end of the paragraph) were recalled better in the auditory presentation condition. These findings demonstrate the modality effect. Also, temporal anaphora led to increased recall of target details in the auditory condition. This suggests "that auditory presentation preserves temporal information more fully than does visual presentation" (Jakimik & Glenberg, 1990, p.587).

Similarly, Glenberg & Fernandez (1988) found a presentation modality difference in order judgments and presentation frequency. Participants more accurately recalled the order of aurally presented words than of visually presented words in a list learning task.

Also, frequency estimates of repeated auditory words were more accurate than estimates of the frequency of presentation for visual stimuli. These results support a temporal organization within the verbal short-term store.

Auditory as well as temporal factors appear to play a role in producing the modality effect. Crowder (1986) investigated the role of articulation and background noise in the modality effect. The author's PAS theory (Crowder & Morton, 1969) suggested that speech gestures (i.e., mouthing or lip reading) have auditory features and so have access to echoic memory. Thus, speech gestures should produce the same advantage for recall of terminal items as blatantly audible stimuli.

For the 1986 study, Crowder instructed subjects to read aloud, to mouth silently, to whisper audibly, or to read silently a visually-presented digit span task under both background noise and no background noise conditions. Results showed superior recall of the terminal item in the three speech/gesture ("auditory") conditions over the non-gesturing (silent reading) condition. Such results suggest the modality effect does in fact occur in the absence of auditory stimulation provided there is a process of speech-like production. Results also showed that background noise decreased recall in all four presentation conditions when compared to the no noise recall scores.

However, background noise did not negate the superiority of recall upon speech and speech-like presentation over visual presentation. This anticipated interaction between noise and presentation was achieved, but only for the whispered presentation. Crowder (1986) found that noise did not negate the modality effect except when items were whispered, wherein the no noise condition produced significantly higher recall of the terminal item.

The role of articulation in producing the modality effect was also investigated by Gathercole (1986). Participants remembered a list of digits presented either visually or aurally (participants read aloud the digits displayed on a monitor). Participants then engaged in a suppression task before written serial recall. The suppression task involved writing, mouthing, or speaking the alphabet in between presentation and recall. Results demonstrated the modality effect, with superior recall of terminal items in the vocalized presentation condition. The suppression task did interfere with recall of the vocalized list only when the alphabet was spoken. Written and mouthed suppression tasks did not interfere with recall of either visually or aurally presented lists.

This finding supports the notion of Penney's (1989) hypothesized A code that received a sensory trace solely from auditory stimuli. Therefore, this information was vulnerable to displacement upon the automatic entry of additional stimuli from the spoken suppression task, but not the inaudible suppression tasks. The act of articulation in the absence of sound (i.e., mouthing) did not access the A code and therefore did not interfere with the modality effect (Gathercole, 1986).

The modality effect may appear in the absence of actual speech sounds but not in the absence of the ability to hear. Engle, Cantor, and Turner (1989) addressed the role of hearing ability in producing the modality effect. Based on the finding that mouthed and lipread stimuli produce the modality effect due to their instantaneous activation of auditory features (Crowder, 1986), Engle et al. anticipated deafness would negate the superiority of gestural/articulatory stimuli to visual stimuli in producing the modality effect. In fact, deaf subjects did not demonstrate improved recall for recency items in either silently read or vocalized lists. Thus, without access to an auditory process, either directly or by association, deaf subjects could not produce greater recall of the terminal list item with vocalized presentation, whereas hearing subjects demonstrated the modality effect. This finding supports the notion of separate stores for auditory and visual short-term memory.

Penney and Godsell (1999) demonstrated a diminished modality effect in "less skilled readers" when compared to "skilled readers," who produced the expected superior recall of terminal digits upon auditory presentation. For the less skilled readers, recall of visually-presented lists was greater for six or more digits. However, no matter the list length, less skilled readers consistently produced the modality effect for the terminal list digit. Penney and Godsell suggest the results indicate the echoic memory in less skilled readers either has a diminished capacity or decays more rapidly than in skilled readers. This research does demonstrate the modality effect in readers of different skill levels, suggesting the phenomenon is not a function of or affected by intelligence or comprehension. Also, these findings further substantiate the integral role of auditory short-term memory in learning.

Not all research into the modality effect demonstrates the superior recall of aurally presented information. Frick (1984) investigated the modality effect in comparing auditory to visual to mixed, alternating auditory-visual presentation. Results demonstrated increased digit span with mixed (half auditory and half visual) presentation, when aurally-presented items were recalled first. "The number of digits that can be recalled immediately after presentation can be increased by non-redundant storage in two different stores" (p. 514). Frick interpreted the results as evidence for separate auditory and visual stores in short-term memory, which supports Penney's (1989) separate streams hypothesis.

Studies such as these indicate the superiority of recall upon auditory presentation under various conditions, and sometimes in unexpected combinations. It may be due to the unique properties of an auditory code, perhaps because of temporal or sequential organization, or because of a lingering sensory trace or echo. Indeed, the modality effect has helped shape short-term memory theory. Might it play a role in memory assessment?

Wechsler Memory Scale-Third Edition: Logical Memory I

Neuropsychological assessment is an integral piece of the diagnostic, research, and rehabilitative functions served by psychologists. "Psychological assessment is crucial to the definition, training, and practice of professional psychology. Fully 91% of all practicing psychologists engage in assessment" (Groth-Marnat, 1997, p. 5). Among the tools employed by these practitioners and researchers, the Wechsler instruments are widely utilized. Three to four editions of the Wechsler Intelligence Scales and the three editions of the Wechsler Memory Scales have made significant contributions to the theoretical understanding and measurement of learning and memory.

The Wechsler Memory Scale-Third Edition (WMS-III; Wechsler, 1997a) is the second revision of the most widely used measure of adult memory (Larrabee, 1999). The instrument represents "significant changes and improvements relative to earlier editions, demonstrating both psychometric improvements, and increased clinical and scientific understanding of memory function and dysfunction" (Larrabee, p. 473).

The Logical Memory I (LM I; Wechsler, 1997a) subtest is a vital component of the diagnostic capabilities of the WMS-III. The LM I subtest is a prose recall measure requiring the immediate recall of each of two brief passages. The Logical Memory II subtest is a delayed recall and recognition task of the two passages. Lezak (1995) states that story recall tests "provide a measure of both the amount of information that is retained… and the contribution of meaning to retention and recall" (p. 456). The LM I prose recall subtest has greater "real world" relevance than commonly used list learning tasks (Lamberty, Lamberty, Winger, & Holt, 1999). "Most daily information occurs in context from snippets of conversation, news reports, or printed text, whereas the recall of lists of words or objects is a relatively artificial task without affording the benefit of contextual organization" provided by the prose recall (p.32). Therefore, the prose subtest as a contextual recall scenario is helpful to neurpsychological assessment in addressing the practical questions of a person's everyday functioning.

Notably, the LM I subtest is sensitive enough to be used independent of the WMS-III battery or with limited other measures of neurological functioning. The LM I alone is very sensitive to memory impairment. The passage of Story A in particular has demonstrated the ability to distinguish between "normal" control subjects and those subjects with "mild dementia of the Alzheimer type" (Brown & Storandt, 2000; Johnson, Storandt, & Balota, 2003). Johnson et al noted that deficits in prose recall, as opposed to deficits in list learning, are prominent in the early stages of dementia of the Alzheimer type.

Iverson (2000) found that only three WMS-III subtests were crucial for accurate diagnosis of memory impairment: the LM I, Verbal Paired Associates I, and either of the two primary visual memory subtests (Faces I or Family Pictures I). However, if LM I or Verbal Paired Associates I was subtracted and a second visual subtest substituted, diagnostic accuracy suffered greatly. Groth-Marnat (1997) cites a seven-test battery to assess memory functioning, which includes the LM I subtest as the only measure from the WMS to contribute.

Present Study

Clearly a versatile and respected measure of memory, the LM I subtest has been utilized in many research protocols. Its widespread use in both research and clinical settings, its psychometric integrity, and its diagnostic accuracy make it a sound selection for further research. As the WMS-III has only been available since 1997, gathering new data is important. Additional research utilizing the LM I may contribute to the literature on the use of WMS-III, and specifically LM I, as a test of memory that is modality specific. One area of research that may benefit from employing the LM I subtest is that of presentation modality and how it affects immediate recall of a prose passage.

The presentation modality of a memory task can affect the serial position and amount of information recalled. The modality effect is a documented phenomenon occurring in recall situations, wherein auditory presentation is expected to result in greater recall, especially of the terminal item, than the visual presentation mode (Penney, 1989). However, some individuals recall more verbal stimuli upon visual presentation than auditory under certain conditions (see Battacchi, Pelamatti, & Umilta, 1990). And yet some individuals recall best upon dual-mode presentation (see Frick, 1984; Tindall-Ford, Chandler, & Sweller, 1997).

In measuring memory, the Luria-Nebraska Neuropsychological Battery, Form III (Golden, 1993) utilizes visual presentation for a prose passage and solicits verbal recall. This presentation strategy is a direct contrast to the procedure of the WMS-III verbal memory task, which presents the prose passage aurally and solicits verbal recall. Does the presentation modality of a standardized memory assessment tool affect the amount of details recalled?

Studies reviewed above have compared auditory to visual presentation, or multiple levels and variations thereof, in demonstrating the modality effect. Some of the reviewed studies compared single-mode auditory to single-mode visual presentation, yet the auditory mode was truly a mixed, simultaneous auditory-visual mode because the participants were reading aloud the visual stimuli (i.e., Crowder, 1986; Gathercole, 1986; Mayes, 1988). Such a condition is not a pure auditory presentation, but a dual-mode presentation wherein participants are actually receiving the stimulus via two senses. Frick (1984) focused on the question of dual-mode presentation versus single-mode presentation, finding mixed-alternating presentation superior to individual auditory or visual presentation, but no studies compared auditory to visual to combined simultaneous auditory-visual presentation.

Also, Jakimik and Glenberg (1990) found superior recall of a prose passage as well as the terminal item with auditory presentation. Other studies considered only the terminus rather than the full stimulus. Perhaps the advantage of auditory presentation over visual presentation extends to overall recall as it does to the terminal item. Or perhaps the superior recall of the terminus significantly increases total recall upon auditory presentation. The various research methods and findings and the conflicting memory assessment practices require further probing into the modality-specific measure of memory.

The present study examined the modality effect in an immediate recall task utilizing three different modes (auditory, visual, and combined simultaneous auditory-visual) of presenting the prose passages from the LM I subtest of the WMS-III. Such research may contribute to investigations into the utility of the WMS-III and into the viability of the verbal short-term memory construct.

Hypotheses

The present study investigated the following hypotheses:

Hypothesis 1: The item (i.e., story detail) in the terminal serial position will be recalled more frequently upon auditory presentation than upon visual or combined simultaneous auditory-visual presentation.

Hypothesis 2: Auditory presentation of the LM I stories will lead to greater recall scores than will visual or combined simultaneous auditory-visual presentation.

CHAPTER 2

METHOD

Participants

College-educated men and women between the ages of 25 and 34 were recruited to participate. This age range is the same as that used in providing some of the normative data for the Wechsler Memory Scale-Third Edition (WMS-III; Wechsler, 1997a). This population was used in an attempt to maximize homogeneity of the sample. Table 1 presents the demographic data for the participants.

A total of 60 participants were equally divided among three conditions, resulting in 20 participants per condition. The sex of participants was not a variable in this study. Potential participants were dismissed or the data excluded if an individual met certain exclusionary criteria set for the standardization samples outlined in the WAIS-III/WMS-III Technical Manual (Wechsler, 1997b). Specifically, those conditions which have the potential to impair memory functioning or perceptual acuity are exclusionary criteria: uncorrected hearing loss; uncorrected visual impairment; current treatment for alcohol or drug dependence; seeing a doctor or other professional for memory problems or problems with thinking; any period of unconsciousness for 5 minutes or more; head injury resulting in hospitalization for more than 24 hours (p. 22).

Design

The current study explored the modality effect in the immediate recall of the terminal prose item of the WMS-III LM I subtest. The research design was a between-subjects comparison of independent groups. The independent variable was the presentation modality of the LM I stories. There were three levels of presentation:

Table 1

Summary of Demographic Information of Participants

Presentation Modality	*n*	Mean Age (*SD*)	Men	Women	Mean Education (*SD*)
Auditory	20	28.3 (2.4)	12	8	16.9 (1.8)
Visual	20	27.8 (3.1)	11	9	15.9 (1.8)
Auditory-Visual	20	27.8 (2.8)	9	11	16.0 (1.3)
Total Sample	60	27.9 (2.7)	32	28	16.3 (1.7)

auditory, visual, and combined auditory-visual, presented as described below. The dependent variable was the number of times the terminal item was accurately recalled, once per story administration, with 3 being the most that can be recalled.

This study also explored the modality effect in the immediate recall condition of the LM I subtest. The research design was approached as a between-subjects comparison of independent groups. The dependent variable was the amount of information recalled (i.e., participants' raw score) of the LM I subtest. The independent variable was the presentation modality (auditory, visual, or combined auditory-visual).

Although participants were not randomly selected from the population, they were randomly assigned to one of the three presentation modality conditions so that each participant had an equal chance of being assigned to a given condition. There were an equal number of participants in each level of the independent variable.

Materials

Only one subtest of the WMS-III was employed in this research. The Logical Memory I (LM I; Wechsler, 1997a) was scored and analyzed. This prose recall subtest is comprised of Story A and Story B, which is presented twice. Each story is broken down into 25 items, each item being worth 1 point, for a total of 75 points for the subtest. Points are given for items accurately recalled regardless of their order of recall. There is also a delayed recall and recognition subtest (Logical Memory II) that was not utilized in this study.

The WMS-III is found to be both a valid and reliable measure of memory. That is, this instrument measures what it purports to measure, and it does so accurately and consistently across time and situations. The instrument as a whole is found to have reliability and validity measures ranging from acceptable to excellent (Wechsler, 1997b).

The Technical Manual (Wechsler, 1997b) reports multiple reliability coefficients. In measurements of validity, the WMS-III is found a valid measure of memory (see Lezak, 1995; Millis, Malina, Bowers, & Ricker, 1999; Price, Tulsky, Millis, & Weiss, 2002). The WMS-III Auditory Immediate Index correlates moderately at .58 with the Wechsler Adult Intelligence Scale-Third Edition Verbal IQ, demonstrating that both indexes measure a verbal construct (Wechsler). The LM I, an aurally-presented subtest, had a low intercorrelation (.14) with the visually-presented Faces I subtest, demonstrating the difference in modal constructs between the modality-specific subtests (Wechsler).

Convergent validity measures have been assessed through comparison studies between the WMS-III and other instruments measuring, among other things, attention, language and memory (Wechsler, 1997b). Of interest here are the memory correlations between the WMS-III Auditory Immediate Memory Index (which is comprised, in part, of the LM I) and the Wechsler Memory Scale-Revised (WMS-R) Verbal Memory Index, the California Verbal Learning Test (CVLT) Trials 1-5, the MicroCog Memory Index, and the Rey-Osterreith Immediate Memory. These correlations ranged from .55 to .75, a moderate convergent validity among these instruments indicating they all measure a similar construct.

In a similar vein, Wong and Gilpin (1993) reported convergent validity of the WMS-R with the Luria-Nebraska Neuropsychological Battery-Form II (LNNB-II). "The positive correlation between the LNNB-II Memory Scale and the WMS-R Verbal Memory Summary Score does suggest a moderate degree of convergent validity between the two tests for assessing verbal memory" (p.853). Similarly, "significant correlations" were found between the WMS-R and the Luria-Nebraska Neuropsychological Battery-Form III (LNNB-III) in research comparing index scores by Bradley, Teichner, Crum, and Golden (2000, p. 115). Research utilizing the Babcock Story Recall Test (BSRT) and the WMS-R LM I demonstrated convergent validity between the BSRT and LM I as well as between the CVLT and LM I. A significant correlation of .49 was found between the BSRT and LM I Story A. The correlation of .52 was also significant between the CVLT and LM I Story A (Horner, Teichner, Kortte, & Harvey, 2002). Such research supports the use of LM I as a measure for memory of structured verbal information.

Procedure

Participants were recruited via written solicitations that provided information describing the time commitment and rigors involved in participation, a copy of the consent form, a brief description of the purpose of this research, and age and education criteria. Volunteers were directed to contact this author via phone or e-mail to schedule an appointment and to have any additional questions answered. This author posted requests for participants in corporation lunch rooms, law school and university student centers, and exercise facilities where permission was granted. The participant pool was generated from a northeastern metropolitan population.

This author greeted participants at her office and led them to the testing room. Participants were instructed to read the consent form (Appendix A), ask questions, then sign and date the consent form, keeping a copy for themselves. Participants completed a demographic questionnaire (Appendix B) before the testing began. The questionnaire assessed participants' age, education, and potential exclusionary criteria. This author then administered the LM I subtest of the WMS-III.

Axelrod (2001) found the administration duration of LM I to be approximately 4.5 minutes. Indeed, the total participation time was no more than 15 minutes. The subtest was administered and the responses recorded and scored by this author, who was trained by a licensed neuropsychologist in the administration and scoring of the WMS-III. In an attempt to control for experimenter effects, only this author had contact with the participants and followed the standardized administration protocol.

The LM I was administered according to the testing condition that was randomly assigned to a given participant. Each of the tracing-paper "record forms" was labeled in advance with "Auditory," "Visual" or "Auditory-Visual." This author then employed the testing condition on the selected record form.

This author read aloud to participants the instructions provided by the administration manual. LM I was then administered one of three ways: auditory presentation, in which this author read the stories aloud to the participants; visual presentation, in which the participants silently read the stories to themselves; combined simultaneous auditory-visual presentation, in which this author read the stories aloud while the participants read to themselves or visually follow the text of the stories. After the story was presented in a given modality, participants were asked, per the standardized instructions, to recall the story.

For those conditions wherein the participants read the text, they were given an actual WMS-III record form to read from. On this form, all text except stories A and B (which are located on different pages) was covered with a piece of white paper secured to the form. After this author read the instructions (substituting and adding directions for the participant to "read silently to yourself" for the visual and combined presentation conditions, respectively), the text was placed in front of the participant, who was instructed to read the text only once. This author removed the text as soon as participants indicated they were finished reading.

This author used a WMS-III record form to record each participant's responses. However, in order to minimize cost and to uphold copyright laws, a piece of tracing paper was placed over the record form to record each participant's responses and to tally scores. A raw score was tallied for LM I, as per the standardized scoring criteria, and was used as the data for statistical processes. Also of note was the number of terminal items recalled, 1 item per story administration, for a total of 3, which was also used as data for statistical processes.

Upon completing the test, participants were thanked for their time and told to contact this author in several months if they would like to be "debriefed" or to learn the results of this research. This author's contact information is included on the informed consent document.

CHAPTER 3

RESULTS

Two memory measures were analyzed in this study: Logical Memory I (LM I; Wechsler, 1997a) recall of the terminal story items and the recall raw score. For each of these measures, a one-way analysis of variance (ANOVA) was used to analyze the effect of presentation modality (auditory, visual, or combined auditory-visual) on immediate recall measures.

Hypothesis 1

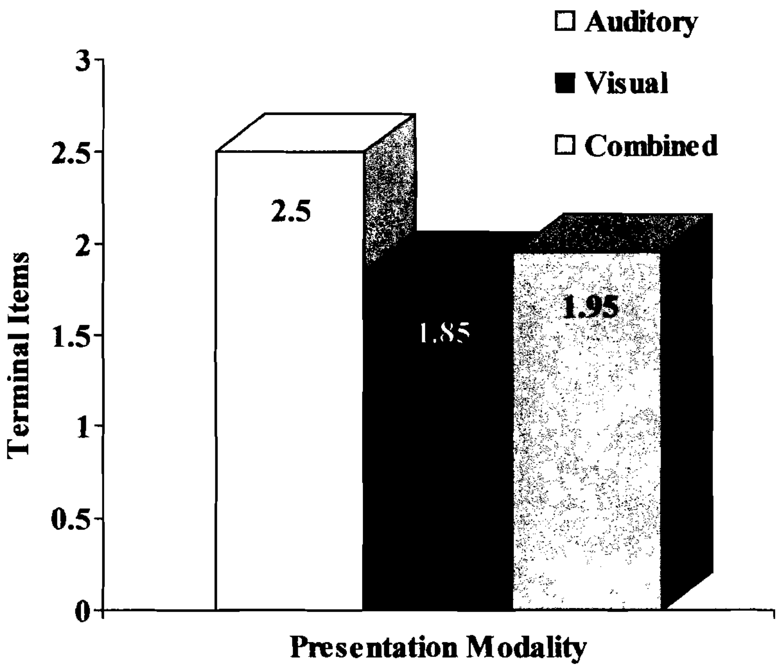
The terminal detail was expected to be recalled more times upon auditory presentation than upon visual presentation or combined auditory-visual presentation. The ANOVA of the terminal item recall yielded a significant effect for presentation modality [$F\ (2, 57) = 3.286, p < .05$]. A Tukey post hoc analysis indicated ($p < .05$) that auditory presentation ($M = 2.5, SD = 0.76$) led to greater recall of the terminal item than did visual presentation ($M = 1.85, SD = 0.99$). Terminal item recall did not differ upon auditory and combined auditory-visual presentation ($M = 1.95, SD = 0.83$) or upon visual and combined auditory-visual presentation. As can be seen from Figure 1, participants recalled significantly more terminal details upon auditory presentation than upon visual presentation, but combined auditory-visual presentation of the prose passage did not differ significantly from either single-mode presentation.

Hypothesis 2

Auditory presentation of the LM I stories was expected to lead to greater recall scores than visual or combined auditory-visual presentation. The ANOVA of the LM I immediate recall raw score yielded no significant effect for presentation modality. As can

Figure 1

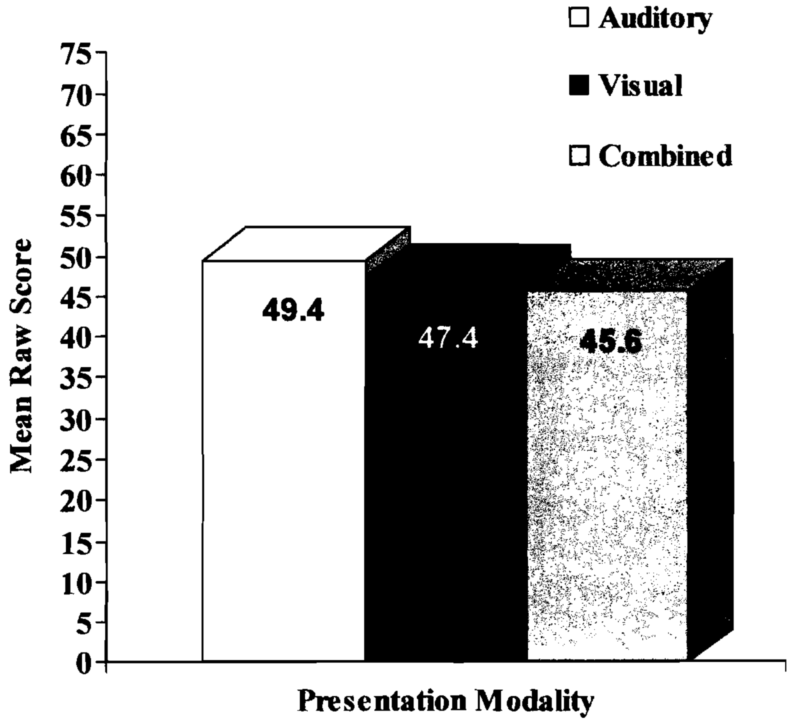
Mean Recall of Terminal Item on Logical Memory I



be seen from Figure 2, participants recalled similar amounts of the prose passage upon auditory (*M* = 49.4, *SD* = 7.16) presentation as upon visual (*M* = 46.9, *SD* = 10.71) and combined auditory-visual (*M* = 45.5, *SD* = 9.37) presentation.

Figure 2

Mean Recall Raw Score for Logical Memory I



CHAPTER 4

DISCUSSION

The present study investigated the incidence of the modality effect in the recall of a prose passage. Previous research has shown variability in the conditions that elicit superior recall of aurally presented information (for review see Penney, 1989). In assessing recall of the terminal item, the first hypothesis was partially supported and the modality effect demonstrated, as auditory presentation resulted in superior recall compared to visual presentation. Recall of the terminal detail upon single-mode auditory and single-mode visual presentation did not differ significantly from combined auditory-visual presentation of the prose passage. Contrary to the second hypothesis, present results did not demonstrate superiority of recall raw scores upon auditory presentation compared to visual and auditory-visual presentation of the Logical Memory I (LM I; Wechsler, 1997a) subtest.

Hypothesis 1

The first finding lends support to Penney's (1989) separate streams hypothesis wherein the different auditory versus visual storage mechanisms resulted in disparate recall. It is possible auditory presentation led to greater recall of the terminal item due to the information's automatic representation in the sensory-based acoustic code (A code). Perhaps an echoic trace remained with participants who heard the prose and allowed them to remember the final detail of the stories. Visually presented stimuli must be enriched internally via the phonological code (P code) for retention, and thus may not have been represented before the participants were cued for immediate recall of LM I.

However, the A code would also have been accessed by the combined auditory-visual presentation, which did not produce significantly different recall than either single-mode presentation. Several researchers have utilized combined simultaneous auditory-visual presentation in their investigations (see Crowder, 1986; Gathercole, 1986; Mayes, 1988) and found such "auditory" presentation superior to visual presentation. Yet the present results are contrary to such findings, as they do not demonstrate superiority of combined auditory-visual over visual presentation. Perhaps the combined auditory-visual presentation condition in the current study was distracting to participants because the researcher read aloud the prose while the participants silently viewed the text. This is opposite the process of the above-mentioned studies in which the participants themselves read aloud the text they were viewing.

The superior recall of the terminal item upon auditory presentation may be due to standardized instructions for LM I which include: "Start at the beginning" (Wechsler, 1997a). The cued organization of the response may have created an advantage for the auditory presentation, which is thought to be organized temporally and/or sequentially (see Beaman & Morton, 2000). Beaman and Morton found recall of the terminus upon visual presentation was better if recalled initially rather than in sequence. Their results indicated recall strategy did not alter the superior recall of the terminus upon auditory presentation. Such temporal organization, along with the properties of Penney's (1989) A code, would allow participants to recall the story in order and accurately recall the terminal detail upon auditory presentation. Yet the spatially organized visual memory, combined with the rehearsal-based P code, would result in inferior recall of the terminal detail due the instructions to start at the beginning. Recall upon combined auditory-visual presentation did not differ significantly from either single mode condition, despite access to the advantageous A code and temporal organization that could have significantly increased recall over visual presentation.

Hypothesis 2

The superiority of auditory presentation was not evident in the raw scores for LM I. One variable that may have influenced the relatively uniform recall raw scores among presentation modes is education. The average amount of education among participants, 16.3 years, may have negated any advantage auditory presentation theoretically had over visual or auditory-visual presentation. According to Tremont, Hoffman, Scott, and Adams (1998), higher education leads to better memory performance. It is possible the language-based nature of the LM I (i.e., prose) makes it susceptible to varied performance by people with different levels of education. "Tests principally influenced by education had auditory-verbal and language requirements [and] were based on stored information" (Reitan & Wolfson, 1995, p.152). Perhaps the participants' relatively high level of education (compared to the national average of 12.0 years; UNESCO, 2000) reduced the variability of their memory performance for immediate prose recall. This would help explain why the results did not support the second hypothesis that auditory presentation would result in greater recall raw scores than visual or combined auditory-visual presentation.

The continuity of recall upon the three presentation modes differs from research finding auditory presentation superior to visual presentation of a prose passage (e.g., Jakimik & Glenberg, 1990). In the present study, participants recalled similar amounts of detail upon auditory, visual, and combined auditory-visual presentation. Significantly higher recall of the terminus upon auditory presentation did not significantly raise the recall raw score for that condition over the other presentation modalities. Such findings demonstrate that no one presentation modality is superior to or should be utilized in place of another mode. These findings are consistent with the standardized administration of LM l, which presents the passage aurally, and the Luria-Nebraska Neuropsychological Battery-Form Three (LNNB-III; Golden, 1993), which presents the prose recall passage visually. However, this does not indicate Wechsler Memory Scale-Third Edition (WMS-III; Wechsler, 1997a) results are valid if the LM I subtest is administered visually or combined aurally-visually, as further research would need to confirm the present findings before standardized procedures are dismissed.

Present findings demonstrate the modality effect in immediate prose recall, wherein the terminal detail was recalled more upon auditory presentation than upon visual presentation. However, these results do not indicate auditory presentation leads to superior immediate recall of the entire prose passage. The increased recall of the terminal detail did not have a significant impact on the overall recall, as auditory, visual and combined auditory-visual presentations led to comparable raw scores. Thus, the modality effect is evident in this memory assessment tool, but does not appear to influence the raw score of LM I.

Limitations and Future Directions

This study may be generalized to the larger population on a limited basis. Due to the small sample size, similar educational experiences and narrow age range, caution should be taken when generalizing outside of a college-educated, adult population. Future research should include participants of a broader age range, with fewer years of education, and of various races, so as to better reflect the general public. A larger sample size will increase the power of the results, and may even produce different, significant results. Research by Reitan and Wolfson (1995) suggests that performance on some memory and neuropsychological subtests declines with increasing age. Replicating the present study with older adults may provide information about the modality effect in a population that has an increased likelihood of memory assessment (Lezak, 1995).

Utilizing a fairly homogenous population allowed for some control of individual differences, but confounding factors may have been involved. The present study could be replicated using a within subjects design, presenting one paragraph aurally, and one paragraph visually to the same participant, attempting further to control for individual differences. Future research should consider how factors such as intelligence, attention and concentration, or reading comprehension may affect the memory process and modality effect. Specifically, research suggests IQ is a factor in memory performance (Tremont et al., 1998); therefore, future studies may incorporate a measure of intelligence in assessing presentation modality effects. It is possible, due to the visual and auditory-visual modes, that reading level or reading comprehension may have played a role in participants' recall performance (Waters & Caplan, 1996). Future studies could treat reading level/comprehension as a covariate or a second independent variable in order to determine the influence on memory or the modality effect.

The presentation modality concerns that apply to memory assessment may also apply to the assessment of other cognitive domains. Replicating this study with other memory instruments, or perhaps intelligence and achievement tests, may increase the utility of these findings. Such research could also be conducted on other WMS-III subtests to learn about the potential effects of presentation modality on clients' scores.

Reitan and Wolfson (1995) and Tremont et al. (1998) suggest that results from a control population cannot easily be generalized to a neurologically impaired population due, in part, to the varied and unpredictable nature of brain trauma and to premorbid functioning. Therefore, for ultimate utility of the LM I and the WMS-III, future studies should assess a neurologically impaired population. Finally, replicating this study using both LM I and the delayed-recall subtest Logical Memory II would contribute substantially to the modality effect research base. "The understanding of modality effects is central not only to an understanding of short-term memory but also for a complete account of long-term memory as well" (Penney, 1989, p. 410).

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APPENDIX A

Informed Consent

This document is meant to inform you of the purpose of the present study and any risks involved therein, as well as to certify your consent to participate. You have been asked to participate in a study titled "The Modality Effect and Immediate Recall of Logical Memory in the Wechsler Memory Scale-III." The purpose of this study is to determine the effects of different presentation modalities on recall of stories in the Logical Memory subtests of the widely used Wechsler Memory Scale-III. If you decide to participate in the study, your involvement will take no more than 15 minutes of your time. You will be asked to sign this consent form, complete a brief questionnaire, and perform a memory task. The questionnaire will ask your age, sex, race, education level, and a few questions to assess potential sensory or memory impairments. The memory task will involve remembering and recalling stories. There are no foreseeable risks or benefits from your participation, as this is simply an assessment study.

Your participation is completely voluntary and you will be free to refuse or stop at any time without penalty. Your identity will not be revealed without your written consent. All information will be number coded and strictly confidential.

Do you have any questions?

If you have any questions later, please feel free to contact me.

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Please read the following paragraph. If you agree to participate, please sign below.

I understand that any information about me obtained from this research will be kept strictly confidential. I understand that I may refuse or stop participating at any time without penalty.

Signature ____ Date_____________

Investigator ______________________________________ Date______________

Please initial here, acknowledging receipt of a copy of this consent form. _________

APPENDIX B

Demographic Questionnaire

Age _______ Sex _______ Race ________________

Highest level of education completed:

______ Some College ______ 4-year college degree
______ 2-year college degree ______ Master's degree
______ Other ______ Doctoral degree

Do you have difficulty with your hearing? Yes No

If yes, are you wearing a corrective device at this time? Yes No

Do you have difficulty with your vision? Yes No

If yes, are you wearing corrective lenses at this time? Yes No

Are you currently receiving treatment for alcohol or drug dependence? Yes No

Are you currently under the care of a doctor or other professional for memory problems or problems with thinking?

Yes No

Have you ever experienced any period of unconsciousness for 5 minutes or more?

Yes No

Have you ever obtained a head injury resulting in hospitalization for more than 24 hours?

Yes No

Are you currently under the influence of a mind-altering substance? Yes No

I, Cara M. Duncan, hereby submit this thesis to Emporia State University as partial fulfillment of the requirements for an advanced degree. I agree that the Library of the University may make it available for use in accordance with its regulations governing materials of this type. I further agree that quoting, photocopying, or other reproduction of this document is allowed for private study, scholarship (including teaching) and research purposes of a nonprofit mature. No copying which involves potential financial gain will be allowed without permission of the author.

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Signature of Author

July 26, 2004

Date

The Modality Effect and Immediate Recall of Logical Memory in the Wechsler Memory Scale-Third Edition

Title of Thesis

Ray Cooper

Signature of Graduate Office Staff Member

8-9-04

Date Received