Gipan
Volume 07, Issue 01, 2025. pp. 43–63
Research Article
DoI: https://doi.org/10.3126/gipan.v7i1.84234

A Review on Word Learning: Compilation of Theories and Experiments Advances

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Abstract

Language learners and users regularly engages in a word-learning experience, demonstrating its huge prevalence. Activation of multiple brain areas, construction of multivariate linkages between mental sub-processes, and, control over numerous external and internal factors are essential for learning a single word, indicating the complex nature of word learning. However, such variables and processes involved in word learning have not received as much attention as required. Words are often perceived as a small element of language and implied as language semantics, so word investigations get overshadowed by language research. The only association of words with semantics has obscured the importance of phonological skills in word learning which needs to be highlighted more. Furthermore, word-related notions and studies are dispersed among linguists, psychologists, and speech pathologists, making it challenging for a new viewer to comprehend the precise nature of word learning because of the insufficient information compilation. The current article gathers data on word learning from different sources, reviewing experimental methodologies and theoretical studies on words from earlier to contemporary investigations. The article also delves deep into understanding the unique individualistic differences and variables influencing word learning. Henceforth, the article presents a theoretical summary and consists of experimental research, showcasing the breadth of word learning for an interested novice learner to apprehend.

Keywords: word learning, fast and slow map, word learning models, word phonology, word learning variables

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Article History
Received: 2025, May 12
Revised: 2025, June 26
Accepted: 2025, July 30

Cite
Gnyawali, D., & Panchakshari, A. B. (2025). A review on word learning: Compilation of theories and experiments advances. *Gipan*, *7*(1), 43–63. https://doi.org/10.3126/gipan.v7i1.84234

Introduction

A word is the fundamental unit of meaning from which larger structures like sentences and paragraphs are constructed (Read & Chapelle, 2001). Meanwhile, learning words is a slow developmental process that increases its pace with age and maturity. Word acquisition milestone is a continuous journey for a learner, first step is the identification of the sound category and segmentation of words from running speech (Westermann & Mani, 2018). Learner then, groups sounds into meaningful units and map words to its object often by guessing. Afterwards, word-learner organizes multiple words into a lexicon, and lastly comprehends the abstract/concrete nature of the word and its variability.

These milestones are achieved only through learners' cognitive excellence, innate ability, and active participation. In the following sections, the same milestones and skills will be discussed. In the first section, word and its learning process will be introduced, first and second language's word differences will be discussed, also highlighting semantics and phonology within a word. Similarly, the second section enlightens on cognitive, innate, neurological, and other models in the compiling literature on word learning. The third section will explore word learning variabilities secondary to variation of participants, situations, and stimuli. The ultimate section will discuss the recent experimental studies identifying gaps and implying future research ideas.

Methodology

Approximately 175 studies were collected from different database searches such as Google Scholar, PubMed, Scopus, Web of Science, Elsevier, Schematic Scholar, and Cochrane Library. The search was done using appropriate keywords to find articles related to the topic, including "Word learning", "Language learning", "Theory of word acquisition", and "Word learning models" across different time ranges, followed by snowball sampling of related articles. Articles included all kinds of systematic reviews, experimental studies, and book chapters. Articles were screened through the analysis of the topic and abstract. Around 40 studies were excluded for lacking topic emphasis; conversely, some studies were chosen separately based on authors who had conducted substantial studies in the field of word learning. Information collected from different articles was reviewed to create a conceptual map with appropriate headings and subheadings. A descriptive qualitative approach was used for writing the information.

Findings

Word and Word-learning

A word is a combination of syllable sequences that signify an idea; thus, word learning requires acquiring the two central elements- a word's form and meaning. Word is learned through the word association process (WA), where a symbolic linguistic term is linked to its environmental referent. Frequent word exposure from diverse or the same contexts strengthens those correct word-referent associations while prunes the remaining incorrect connections. (McMurray, Horst & Samuelson, 2012a). The concept refinement is further assisted by reinforcement and conditioning (Costello, 1967) gained from both external and internal sources for every correct association.

Standard word learning timing is often inconclusive due to the differences in word comprehension and expression mastery time, where comprehension typically precedes word expression (Clark, 1993). In debate, the ability to grasp word meaning, reason comprehension level is considered as 'standard word learning', whereas others support 'expression time' as a relevant parameter for its inclusivity of forms, meaning, phonological identification, phonological memory, and semantic knowledge (Lieven, 1997). Additionally, Laufer & Goldstein (2004)'s four hierarchical levels of vocabulary acquisition milestones support recall skills to be advanced than recognition skills, hence suggesting the word expression as an indicator of the word learning completion.

Younger infants with limited brain maturation and cognitive resources regularly learn words despite the complexity in the process, suggesting a pre-equipped ability. Advanced research on these prerequisites for word learning showcases that the primary requisite is an ability to perceive the phonemic difference(Swingley & Aslin, 2000) and the ability to extract the keyword element and word-onset cues using the subtle pause and frequency signal (Seidl & Johnson, 2006). Likewise, the innate sense of 'mapping' viz. 'innate biases' that word would always indicate to the environmental referent (Qunine 1960, Pinker, 1984), and, 'matching urge' where infant matches the segmented word or word-like proto-word to a referent building the meaning (Jusczyk, 2000) are other essential prerequisites.

Meaning and Form- Two Pillars of the Word

Oral word is a composition of phonemes; written words are composed of graphemes, where both graphemes and phonemes relate to sound and create the structural form of a word. This word formation, generating a word label, is linked to a higher conceptual map, often similar to phonology and semantics linkage. Collection of the 'word form- phono unit' and addition of a 'semantic concept – referent' enable word learning.

The Semantics of Word Learning

Mapping- the meaning-assigning process, could be a single word-to-referent mapping, aka '1:1 mapping', or two-language word to single referent, aka '2:1 mapping'. Sometimes, overlapping mapping of synonyms and erroneous mapping like 'over-extension' and 'under-extension' may occur during word semantic development. Once the surface meaning and denotation of a novel word are learned, the complex meanings and word relations are learned later through complex association and organizing skills.

The learned words are systematically organized in the brain at the long-term memory centers, each word's meaning is related to other available word meanings through the lexical organization process in "mental lexicon". Unlike the alphabetical listing format followed in the dictionary, in the mental lexicon, the node and lines organization format is likely followed. The hierarchical word organization of superordinates and subordinate levels connected by a line, with unique word core characteristics and descriptors attached to each node, is well accepted (Collins & Quillian, 1969). Here, the 'animal' lies on the uppermost level, followed by a 'dog' on a level below, and a 'Chihuahua' on the bottommost. Equally interesting, a spreading semantic activation network (Collins & Loftus, 1975) organization pattern, where the related words, inconsiderate of the grammatical category or semantic category, are placed nearer, i.e., red-firetruck-siren are placed closer to each other. Carter (1988) claims that lexical organization favors the lexical relation of co-hyponymy/synonym organization, such as 'butterfly-moth', enabling better memorization and time-efficient recall. Meanwhile, Mnenq & Worren (2004)'s revolutionary novel 'non-linear lexical organization' postulates a node format for word organization where new lines are formed to connect newer items to an already existing network of older items.

Learned word's collection is called vocabulary which only relates to word meaning, thus it is a superficial word-learning indicator (Vlack, 2013), while the term 'lexis' indicates simple denoted meaning, additional connoted meaning, its synonym, antonym, frequency, collocation and entire network of meanings with the word breadth and word depth (Meara & Fitzpatrick, 1997; 2000). The 'lexical breadth' approximates the total known words of the language, and the 'lexical depth' constructs a multi-dimensional aspect of meaning, spelling, morphological property, syntactic property, pronunciation, discourse feature, and word usage frequency (Qian, 1999). This explains the complexity of word learning, which is not just superficial meaning familiarity, but incorporates attaining the word's lexical competency to its depth and accuracy. A famous five-stage model of lexical development by Meara (1996) with provision of linear as well as bi-directional progression as well as regression between zero and five levels of lexical knowledge. The decontextualized word-to-meaning presentation may only result in vocabulary growth, but possibly won't produce complete lexical development (Shen, 2008). This explanation implies that the meaning of the word is a vast multiverse; basic meaning learned in the initial stages, followed by its in-depth meaning later on, hence word meaning achievement is a continual and complex process that eventually incorporates knowledge of phonology, syntax, and pragmatics. The semantic learning deficits are the primary reason for word learning deficits (Nippold, 1992; Rice et al., 1994), along with lexical storage and encoding deficits (Leonard,1998).

Phonology in Word Learning

Grapheme and phoneme are the phonological constituents, the sole sound element as well as

the framework of the word. During novel word learning, the 'phonological buffer sketch-pad' serves as the memory aid, allowing sound to be processed and linking orthography-to-phoneme to facilitate word retention (Gathercole & Baddeley, 1989). However, the ability to attend, detect, and manipulate sound units of language marks phonological awareness, a primary prerequisite for phonological development. Additionally, the phonological skills assist in sound segmentation and combination for word production, and phonological memory assists in syllable sequence storage, memorizing complex words. Achievement of advanced phonological skills like native-like phonological rules, advanced phono-tactics, and higher phonological memory correlates with increased lexical development. The timing of phonological development in children parallels that of vocabulary acquisition timing, highlighting a possible causal relationship played by phonology in the receptive and expressive vocabulary spurt.

Deficit in any of three phonological parameters-awarenesss, skills, and memory results in constrained word form learning. Children with average phonological awareness and average phonological skills but poor phonological memory perceive, encode, store, and reproduce novel words as a 'holistic whole' (Hu, 2003; Walley, 1993) in an inefficient manner. Word learning, meaning mapping, word recognition, and word modification couldn't be completed with obscure and incomplete phonological patterns (Hu, 2003). While learning the unfamiliar phonological forms, phonological memory plays a crucial role (Baddley, 1998), and such occurrences are frequent with novel word learning. Phonological memory provides temporary storage of unfamiliar forms until the permanent representation of the meaning of novel word construction is completed as per the phonological loop model. Phonological memory skills are a better predictor of word learning than phonological skills (Yang et al., 2021). However, in the case of bilingualism, the resemblance of two languages majorly impacts word learning, where the more the resemblance in form, sounds, and phonological structure, the better the L2 forms are. While higher the phoneme and the phonological difference, higher attentional demand and precision in detail is required. In support, Hu (2003) found the difference in the shape from their first language, precise attentional demands for addressing minute phonemic details being challenging for an L2 word learner leads to gestalt storage of words as it is, and leads to constraint holistic learning. These ideologies indicate the importance of phonology skills for word learning.

Mapping in Word Learning- Slow Map and Fast Map

The word learning occurs slowly until a certain time frame, and grows exponentially after that. The slow-formed mapping builds the accurate concepts and associations, while the faster-formed mapping generates shallower concepts. A preliminary guess and initial referent selection made for a word label is called a fast map (Carey & Bartlett, 1978), while a wider knowledge about words is accomplished afterwards with more experience, called a slow map. Slow map empowers the child to learn categorical, superordinate, and syntax understanding of words, not just the referent (Swingley, 2010). Children showed evidence of fast mapping by making frequent new lexical entries and maintaining them for several days, while their ability to relate to words, concepts, and categorize in structure in the later days showed evidence of slow, extended learning. Children who achieve a vocabulary spurt were found to already know the categorization concept for words, which enabled them to assign novel words to categories faster than those without a vocabulary spurt (Lederberg & Spencer, 2009; Mervis & Bertrand, 1994).

Children generate a quick rough hypothesis about the novel encountered word (Markman & Hutchinson, 1984a, 1987 b), and, narrows the meaning using the linguistic and non-linguistic contexts by fast mapping (Carey, 1798), 'mutual exclusivity principle' (Markman & Hutchinson, 1984a) and 'principle of contrast'(Clark, 1983). The critical period is the time frame during which any development peaks, and following that period,

the development diminishes. Studies show similar word learning ability in children and adults, while children outperform adults in learning phonology, syntax, and morphology learning, showing the existence of critical periods in these parameters. (Newport, 1990)

L1 and L2 Word Learning: Similarity and Differences

Lexical development begins around a year, with a vocabulary spurt at 17-19 months (Nelson, 1973); 25 months (Kern & Gayraud, 2007), and non-noun words around 2 years (Samuelson, 2002). Categorization abilities facilitate the vocab spurt, while shape awareness facilitates object descriptors. The vocabulary spurts are equally common for L1 and early L2 bilinguals (Ellis & Beaton, 1993).

L1 word acquisition requires an individual to develop word knowledge, world knowledge, meaning-form association, word connection, and systematic lexical organization. Meanwhile, in the L2 learning trajectory, L1 and L2 equivalent words are associated, and the L2 word and referent's direct connection. (Winney & Alsaedi, 2008), Unlike the concept-to-word label, L2 learners could skip the stage of developing lexical principles again (Lia et al., 2009a). A clang nature L1-L2 association pairs words with similar phonology and word form; syntagmatic relation association pairs similar word functions are paired; or, may have a paradigmatic association which pairs L1-L2 words of the same class, cognates together (Meara, 1983; Soderman, 1993; Wolter, 2001). Frequent active recall facilitates recall accuracy and fluency of L2 words (Shintani, 2013). The L2 word organization is based on the semantic and phonological similarity of two languages (Ranice P. J, 2011).

Learning a word and building the lexicon boosts the semantic aspect of language, advances the foundation of vocabulary, and overall language proficiency. L1/L2 proficiency relies on their lexicon sizes and word usage. In the acquisition of L2 vocabulary and WA (Markman & Hutchinson, 1984b) innate principles of whole object assumption, mutual exclusivity assumption, taxonomic assumption, and prosodic biases (Ellis & Beaton, 1993) play a role. Iverson (2012) claimed cues like interlocutor cues of the communicator are responsible for word label identification for second-language bilinguals. Similarly, pauses (Lyu, 2010) and frequency changes (Keating & Kuo, 2012) facilitate recognition of the distinctive word unit from the speech stream of a spoken foreign language, while for the tonal languages, the pitch variation at the syllable level is important for word label identification. The pragmatic and social-interaction bias is absent while acquiring the L2 word (Brooks & Tomasello, 1999)

As word learning relies on the context of word exposure, the environmental factor of input differs for L1 words and L2 words, and results in differential word learning. The L1 vocabulary has an advantage in the quality and quantity of input from the naturalistic environment in the varied contextual exposures. Both the quality and quantity of language input also vary for L1 and L2 (Lia et al., 2009b). Naturalistic exposure with scaffolding, child-directed speech from a caregiver, contextual learning, depth of the concept, and informal teaching are advantages experienced by L1 learners, which in turn help better learning of L1 words (Brooks & Tomasello, 1999). Meanwhile, L2 proficiency and L2 lexicon are highly influenced by formal learning situations and individual differences, including age, proximity, memory, and motivation, which subsequently affect the development of the L2 and L2 lexicon. Factors like exposure to language, education, socioeconomic status, dialect, and native language also affect novel word learning (Mallikarjun, 2002).

Gullberg & McCafferty (2008) claim a beneficial role of L1 in learning L2 words, especially easing L2 word learning with existing word categories in L1. Nonetheless, another contradictory opinion of interference from L1, (Glennen, Rosinsky & Tracy, 2005) states the tendency of L2 learners to over-rely on the first language structure, accent, phonology forms, and co-ordinated word vocabulary for

reading, writing, and speaking purposes, leads to immature development of second language and L2 vocabulary. Gass, Amsterdam, Benjamins & Williams (1993) acknowledge that old language may cause both positive and negative impacts during L2 learning.

Models of Word Learning

Word Association Models

Word label-to-referent linkage is a theme of this model. Several researchers follow this paradigm to explain word learning.

A Lexical Inferencing Model. This model (McMurray et al., 2012) explains how a learner tries to extract the basic word information from the contextual information by applying the referential and constraint approaches. The referential approach helps identify a probable referent for the linguistic word, while the constraint approach helps refine and narrow the referent. Consequently, the correct word-referent association is strengthened with multiple exposures, and the incorrect candidate link is eventually weakened. Proponents believe this approach explains sudden vocabulary spurt in children.

PbV Hypothesis Testing Model. With some similarity to the lexical inferential associative notion, introduced a newer model where an individual makes an arbitrary association between a word label and one of the objects which may not be accurate, and later verifies and rejects the proposal with future encounters. The initial word referent association occurs faster per this PbV model, in contrast to slow and gradual WA association by Samuel Horst.

The Dynamic Associative and the Statistical Model. The dynamic association model highlights the WA in cross-situational contexts in more depth (Yu & Ballard, 2007). The consistent selection of suitable referents from the competing referents occurs for word learning in a dynamic, cyclic, and continuous fashion. The Bayesian approach is used for checking hypothesis validity about a word referent, and alternative hypotheses are accepted when truth is not found per hypothesis or when, assumptions criteria are not met. Hebb, (1949) using neuronal models made a similar hypothesis, citing the Hebbian learning principle, demonstrating an increase in synaptic connections for the correct pair. Benitez (2021)'s statistical learning principle conceptualizes the ability to track probabilistic regularities in frequently occurring and varying sensory input conditions for learning. The same statistical learning principle is used for word learning in the 'statistical model of word learning' (Yu & Smith, 2007). In this model, authors explain how multiple inputs of words from numerous situations get gathered, and those accumulated input goes through a process of reflection and analysis to identify the pattern of input (Yu & Smith, 2012). This code of input resembling a statistical formula is thus utilized in the identification and refinement of the referent repeatedly. The word will be stored and updated with the most appropriate word referent, and statistically appropriate decisions will be made based on aggregated statistics. Statistical inference happens over trials with cognitive constraints of memory, prior knowledge, and attention (Smith, Suanda & Yu, 2014).

Staged Model of Word Learning

Word learning is claimed to occur at different stages, where the basic meaning of the word is learned in the initial stage, while advanced concepts and grammar are learned in the later stages. The fast-slow map and QUIL 'Quick Incidental Learning' concepts revolve around this ideology. Hoover, Storkel, & Hogan (2010) claim that word learning is completed in three stages. First is the "triggering stage," where an individual identifies a novel word and pays attention to it. The second stage, "fast mapping," is where an individual tries to link the word form with the referent in the first few exposures. The third stage, the "extended mapping stage," is where an adult-like understanding of meaning is learned from overtime exposure (Carey, 2010; Carey & Bartlett, 1978). To explain a similar phenomenon of extended mapping, "configuration and engagement," term is used, where an individual learns phonology, meaning, and the syntactic form

in depth only in the later stages. Likewise, Oetting, 1995) introduced the term QUIL, standing for 'Quick Incidental Learning', to refer to children's partial understanding of word meaning in context in the initial stages without ostensive parental reference and prompts (Oetting, Rice & Swank, 1995). QUIL is similar to fast mapping, in which only surface knowledge is obtained.

Cognitive Models of Word Learning

This model accentuates the cognitive processes employed by the learner and their active involvement during word learning. Cognition, working memory, and the intelligence quotient impact word acquisition (Marchman & Fernald, 2008), and further development of cognition and analytical power with age enable the learner to acquire more vocabulary.

The Emergentist Coalition Model. This model emphasizes a process of deduction, where the child actively relies on the contexts of communication to identify the word and its referent, by making active use of his attention, pragmatics, and cognition (Hollich et al., 2000). They propose that intrinsic and extrinsic cues- the gestural, the phonological, and the pragmatic cues are utilized together in generating statistical information to assist word learning. The attention of the child to cues and his active role facilitate learning in the early stage. Moreover, these same cues are refined and added over time to support optimal learning and gaining advanced concepts of category and other concepts.

The Constructivist Model of Word Learning. Constructivist language learning theories also support the cognitive model by stating that every child learns from their own experiences and reflection on those experiences (Tomasello, Garagnani, Wennekers & Pulvermüller, 2017). The 'constructivist model of word learning' emphasizes a child's use of cognition to learn words, where the child actively participates in finding meaning and problem-solving during word learning (Lin, 2015). Likewise, found the interrelation of form, content, and use as the source of word learning, and acknowledged the vocabulary spurt to be a result of linguistic development, cognitive development, categorization abilities, conceptual development, and the development of constraints on word learning.

The Neurogenic Model of Word Learning

This model focuses on the neuroanatomical origins and different brain areas' activation in word processing and word learning (Edelman & Gally, 2001; McClelland, 1995). Word processing occurs in two stages, where the initial 'phonologic form processing' results in activation in the hippocampus area, followed by a later 'semantic stage' of word learning results in activations in the hippocampus, neocortex, and sub-cortex and ultimately leads to long-term storage. Likewise, how any repeated actions instigate neuronal adaptation, stronger neural connections, robust firing, and learning is explained using the Hebbian model of learning (Hebb, 1961) with a digit recall experiment. Neuro-anatomical perspective of learning loosely resembles the WA concept of pruning and strengthening by McHorst and explained by 'Hebb effect as word learning model' proposed by Norris and Page (2008, 2009). Following this, the Hebbian paradigm is widely used in word memorizing experiments and long-term storage of the speech sound sequences, words, and non-words using non-word recall tasks (Norris, Page & Hall, 2018), non-word-to-picture association tasks (Szmalec, Page, Duyck., 2012; Mosse & Jarrold, 2008), lexical – decision tasks, where all experiment aligned with Hebb affect word learning model.

Word learning studies by electrophysiological measures, like Electroencephalogram, and Negative 400; and imaging technologies like fMRI and BOLD studies also supports the neurological model. Mestres, Rodriguez & Münte (2007) EEG studies on novel words found differentiated brain activation patterns for novel and non-novel words and word learning to be achieved over three repetitions. On the contrary, an EEG study (Berens, 2018; Batterink & Neville, 2011) and an N400 study (Partanen, Leminen, de Paoli, and Bundgaard, 2017) showed that ten repetitions were required for word learning. Memory built-

up traces for phonological forms were obtained during in tenth repetition during novel word learning in the N400 study (Partanen et al, 2017). Likewise, Berens, Horst J, and Bird C, 2018)'s experiment using blood–blood-oxygen-dependent parameters in MRI found a rapid representational shift in the hippocampus with word learning. The electrophysiological tests showed evidence of neural engagement in word learning, supporting the concepts of fast map, slow map, maturation, and novelty, all proposed sub-processes of word learning.

The Memory Models of Word Learning

When the words are temporarily stored in the storage, the word forms are processed in the phonological storage section of the working memory model, enabling the word learning and permanent word storage (Baddley, 1978). The same proponent, later with other researchers, claimed, that for a word to be learned, the recall of a word was required, and for the word recall, the word forms must have been stored. (Baddeley, Gathercole & Papagano, 1998).

Computational Model of Word Learning

The model claims of an artificial neural network that mimics the primary computer program and uses statistical measures for identifying word meaning, word synonym, or the newer area of formation for storing novel words with new meanings without removing older words (Westermann & Twomey, 2018). This model emphasizes analyzing the word environments and contexts like separate processing units, which ultimately eases ruling out the word to its possible referent (Yu and Ballard, 2007).

The Multimodal Model of Word Learning

This model emphasizes the importance of modality for learning any word. Using the Hub and Soake architecture, the "word referent model" was proposed, where the information from the gestural cues, phonology cues, prosody cues, and semantic cues from all modalities was integrated in the integrative layer in an unconstrained fashion. Later, Plunkett (1997) simplified Plaut's word referent model and created a simpler version named "connection modeling of non-linear word learning." The images are fed through one channel at the retina, while the labels are fed through the other channel, and an "auto-association link" was generated between those two. Plunket explained how an individual must create a mental image at the output, for every input of word-label, for better word comprehension. Similarly, for the expression, how an individual must produce a label at the output for an image sent as input. This model explains the non-linear trend of vocabulary growth and focuses highly on experience-driven learning (Plunkett, 1997).

The Innate Bias and Constraints Principle

Alike to linguistic theory and innate concept, children are born with some constraints and biases in operating with the meaning of words for world-word mappings (Markman, 1994), and 'pragmatic constraints' is the innate bias of the parent-child interactions Rowland, 2014) during word learning. The 'six innate principles (Markman, 1994) aka 'two-tiered lexical principles' shows a developmental pattern of bias acquisition for word learning named reference, extendibility, and object scope under the first tier, and; categorical scope, novel name-nameless category, and conventionality under the second tier (Golinkoff & Mervis, 1994) where two tier develop successively and within tier is simultaneous.

Child maps a word label to the references of objects, actions, and attributes (Principle of referencing) and believes each referent in the environment has a name (mutual exclusivity bias) (Kalashnikova, Varghesh, Giovanni, Edmund & Burnham, 2018; Markman & Wachtel, 1988) and searches to attach a novel name to a referent (Lexical gap filling hypothesis). Child uses old label to refer new referent with a similar character (extendibility principle) and uses word to denote the whole object as opposed to part denotation (object principle). Learner extends label to a referent when the category and exemplar function match (categorical scope principle) and assigns novel label to only a novel referent (novel name-nameless principle). Lastly, the child has an urge

to use an adult-like form by avoiding neologisms and proto-words as a result of the 'principle of conventionality'.

The pragmatic approach and social interaction biases enable a learner to learn the violations and contradictions of natural word learning biases (Brooks & Tomasello, 1999). Besides this, an innate ability to perceive the world from the stream by extra-linguistic cues like intonation, pitch (Fernanld, 1991), and amplitude (Messer, 1981), and, other extra-linguistic cues like ostensive pointing, deictic gestures, eye directions, and eye gaze.

Variables in Word Learning

Different factors are involved in word learning, among which the repetition of words is a major factor. Quick brain activation was found to be caused by a condition of multiple word exposures (Gray, et al. 2020; Levy & Cowan, 2020), which they implied as a result of neuronal linkages between word referents and word forms. Hebbian learning also supports neuron linkage and faster reaction time with multiple repetitions of words. Gray et al. (2020) did not find word learning to be affected by the length of word structure but found the role of phonological memory in learning words. In the early stage, the influence of phonology was found to be more than semantic and, later, vice versa. Similarly they identified word exposure frequency, neighborhood density, phonotactics, phonological similarity, contexts, and learner factors as variables in word learning (Gray et al., 2014). Different studies investigating similar word-learning variables are subsequently discussed.

Participant-related Variables in Word Learning

Young children have supreme abilities in learning words and utilizing contextual information to guess the meaning, ignoring variation in word form by ignoring multi-speaker variability. A comparative study revealed child learning the highest number of words than adults despite the wide disparity of mental lexicon for L1. A child's response to cues during learning indicated better associative learning for novel words, while an adult relies on phonological memory for learning novel words (Service & Craik, 1993). The difference in processing a word/language might be the neuroanatomical differences between the mature and developing brain. Children are found to learn words from the environment by using a "statistical learning approach" using the principle of "associations" (Bloom & Markson, 1998). Plunkett stated that children are built with a natural bias to learn words, despite numerous words and infinite referents. They can strip the word from the flowing conversation and link the word to the exact referent by solving referential uncertainty (Quine, 2019). So, according to natural bias, a child maps a word to a whole object, not its parts, color, environment, or other. A child develops a complicated network and uses environmental statistical analysis to learn new words (Plunkett, 1997). The total word vocabulary of 2 years is around 200 words, six years is around 9000 words, 18 years is around 40000, and adulthood is 80,000 (Miller, 1991; Templin, 1957).

Sleep. Studies show that sleep helps word learning in the consolidation process (Davis & Gaskell, 2009), especially in children (Bloom, 2000; Weighall et al., 2017). The systematic review study done by analyzing 25 studies shows that sleep benefits word acquisition and consolidation compared to wakefulness, thus facilitating word learning (Schimke et al., 2021).

Gender. With mixed findings, some researches have shown women outperforming men in cognitive, linguistic tasks like verbal fluency, synonym generation tasks (Maitland et al., 2004), and word learning tasks, while, few others have found no such differences (Allendorfer et al., 2012). The neurological differences and the neurocognitive mechanisms differences between genders, i.e., women having advanced declarative memory, resulted in better language skills (Ullman, 2004). Women use native phonology more often than men, resulting in better phonologically similar novel words. Girls outperforming boys in novel word learning tasks was assumed to result

from better phonological and semantic familiarity effects (Kaushanskaya et al., 2013) and a long-term storage advantage. (Bolla-Wilson & Bleecker, 1986; Bleecker, 1988) Found better wordlist recall by females and found that paired associative word recall tasks were performed better by females.

Linguistic Variables in Word Learning

Word Classes. A word can be classified broadly into content words and functional words (Haspelmath, 2001). The nouns, verbs, adjectives, and adverbs fall under content words, where such words have a concrete and specific meaning. The functional word category comprises conjunctions, articles, auxiliaries, particles, and prepositions, which have more abstract meanings. The rate of development of words of each grammatical category varies. The abundance of nouns in the early vocabulary shows object mapping, facilitating word learning in the early stages. Grammatical categories like prepositions and conjunctions are learned better contextually, from the sentences, while the noun words can also be learned with the isolation word presentation (Quine, 2019). Similarly, adjectives and verbs are found to be learned slowly (Childers & Tomasello, 2002). Children are sensitive to the perceptual cues of objects, enabling them to learn concrete nouns better. A recent computational model of kinship (Mollica & Piantadosi, 2022) showed a probability of words of a different class following a unique model of learning.

Imageability. Words are the referents to abstract and concrete concepts of action, nouns, and modifiers, so words may not always be picturable. The typical example of the word apple is likely to create an accurate depiction of an image of red color fruits, but the same may not be expected for words such as "Animal" and "snow," which may be open for multiple images, or, the word like "hate" which is strongly abstract may not be represented by pictures. The frequency of words, exposure to words, and lexical quality determine imageability. So, the more imageable, the better the word learning (Fliessbach &Weiss, 2006).

Context. Words are often taught in a rich contextual environment, which further adds to building a solid semantic foundation for long-term memory consolidation. A context may be of linguistic, semantic, pragmatic, discourse, or any environmental circumstance that causes one to infer meaning differently (Christiansen & Dahl, 2005). However, there is a trade-off between rich contextual learning and cognitive strain. The richness of using multiple informative words may overuse working memory resources, and cognitive processes have to be fragmented into multiple words. On the other hand, a non-rich context-i.e., just a word may create a poor foundation of information, but since utilizing fewer resources, entire cognitive processes may be deployed on a single word to ensure effective learning. In addition to this, the "lexical legacy hypothesis" suggests that encountering words in diverse linguistic contexts leads to better semantic processing (Schimke et al., 2021).

L2 learning through rich context results in deeper processing and better retention skills (Grace, 1998; Hulstijn, 1992). However, the contending view shows that rich contextual exposure could result in unnecessary semantic-lexical activation, making the process more complex and intricate to comprehend (Choi et al., 2014). Similarly, (Hoffman & Woollams, 2015) has shown highly diverse contexts leading to semantic activation variability and slower synonym judgment, and similar results were replicated in other studies where words from highly diverse passages had slower recognition scores with higher synonym generation scores (Johns, Dye & Jones, 2016).

Phonology. Extended exposure to language by a caregiver lead to categorizing native-like sounds from non-native sounds and prosody in infants (Lia et al., 2009b). "Prosodic bootstrapping" enables a child to learn the separate word and word boundary along with key stressed words to acquire words better (Soderstrom, et al., 2003; Doughty, 2003). A study conducted using the infant's head-turning task showed that the new

words were learned rapidly when the novel words resembled old learned phonological forms (Tincoff & Jusczyk, 1996). This can be implied by the memory of phono-tactics patterns that are encoded and stored. Vocal production abilities, increased consonant inventory, and sub-vocal rehearsal were found to assist word learning. (Majorano et al., 2019). The increasing length of the word and unfamiliar phonotactic rules create a load on the phonology system, resulting in poor word learning (Papagno & Vallar, 1992).

Orthography. The traditional way of word learning, especially for a second language, is through formal reading. The orthography of the print is converted to phonics, along with generating the semantic representation of meaning. The lexical quality hypothesis suggests how a reader can identify words accurately through multiple readings (Schimke et al., 2021). In a cross-sectional comparative study (Zhang, 2017), the students with L2 as the Chinese language with English and Singaporean L1 language showed that familiarization with the word print was correlated more strongly with word learning.

Frequency of Word. Multiple repeated exposure to words creates a strong association. This association enables better learning and faster retrieval. High-frequency words also have the property of being exposed to many diverse contexts, which is the actual reason for better learning rather than just repetition (Adelman et al., 2006). Smith and Blythe's (2010) study showed that when referential uncertainty is low, participants generally apply a rigorous eliminative approach to cross-situational learning. When referential uncertainty is high or exposures to different words are interleaved, participants apply a frequent approximation to this eliminative approach.

Other Variables

Exposure Modality Conditions. Canalization and degeneracy help structure language and word learning. Canalization, a result of learning, resists variation, enabling consistent perception despite differences. Degeneracy allows varied inputs to produce a common output (Edelman & Gally, 2001). Rich language exposure, including multi-source input, linguistic and modality richness (Monaghan et al., 2018), prosodic richness, and redundant information, supports canalization (Monaghan, 2017).

Mayer (2014) proposed a dual-channel model, with separate visual and auditory channels for stimuli. Given limited human processing capacity, metacognitive strategies enhance storage and processing. Active involvement is key for learners to synthesize and store words meaningfully for future retrieval (Teng, 2024).

Intersensory Redundancy Hypothesis suggests that multisensory cues can hinder attention to relevant information by splitting focus (Bahrick et al., 2012) . However, multimodal input aids word learning, especially for children, as shown by Yurovsky et al. (2013). Effectively using sensory cues in word learning can adapt a learning system to diverse environments, even those with deficits (Westermann & Mani, 2018; Christiansen & Monaghan, 2016).

Memory. Word learning involves encoding information into long-term memory (LTM), where it can be accessed in new contexts after a time delay. Working memory plays a crucial role in processing novel words and encoding them (Nie et al., 2019; Baddeley, 2010). Research on SLI populations with phonological deficits shows poor word learning, suggesting that the phonological loop and sketchpad, responsible for temporary word storage and processing, are impaired (Nie et al., 2019).

Word learning is dynamic, with previously learned words at risk of attrition, forgetting, and interference. Retention depends on recall frequency, depth of processing, and links to existing knowledge. Poor consolidation of novel words into LTM—due to low-quality input, ineffective phonological rehearsal, disorganization at the lexicon level, or weak connections to older concepts—can hinder word learning. Interference occurs when new information disrupts older memories or vice versa. Early studies of forgetting,

like those using nonsense syllables, showed that short-term memory doesn't guarantee long-term storage. Evans (1990) further distinguished between "primary memory" for short-term retention and "secondary memory" for longer storage.

Word learning occurs in two phases: "situation time" (during a single naming event) and "developmental time" (after the initial presentation, lasting days to months). During situation time, external cues and gestures aid learning, while in developmental time, older cues lose effectiveness, and recall becomes permanent, with older information forgotten.

Recent Trends in Word Learning Studies

History shows the word was regarded as a key to language in the early 1990s; in response, the Saussure's theory in 1916 viewed the sign/word as the center of linguistic analysis and stressed comprehending the word's function. However, with the advent of Noam Chomsky's syntactic approach in the mid-nineties, the word was valued as a constituent of syntax and functioned to combine to form complex syntactic sentences around 1957. Following this period, a paradigm shift in viewing language as a sequential process with input, processing, and output processes arose. With the rise of the concept of computational linguistics by Davis Hyes in the 1960s, highlighting processing, different language models were constructed to understand the language. Late 1900s, the social and pragmatic perspective on language 1980s showed language to be highly influenced by contexts and interactions, and how word meanings were acquired from contexts, interactions, and intentional communications. This shift in language caused word learning preliminary studies on context exploration, motherese, and word patterning. The modern era recognizes multilingualism, languages shaping identity ideology, and has recently emphasized language endangerment. Concurrently, a distinct pattern of word usage has been seen in the realm of words. Instead of using synonyms or more polished words, a single word is often used; colloquialisms and slang are used more often, and the usage of emoticons and acronym words over sentences is accelerating. These modern word selection prioritizes communication over formalism and emphasize the value of word usage as equal to word form and word meaning. While word learning studies are still not advanced and accelerated in pace, contemporary studies are still exploring the variables that started decades ago, and modern-era word differences are not focused.

In Past two decades, studies carried out on word learning can be summarized in terms of non-experimental longitudinal studies, where observation of the natural acquisition of words and/or natural bias development over a period was researched; and experimental studies, where novel words are learned in different training situations, often unnatural training setting. The lengthier time constraints, attrition of subjects, and poor control over confounders and test variables were the reasons behind the popularity of experimental studies over longitudinal ones. The experimental studies have been exploring multiple participant-related, situation-related, word word-related variables. In the participant-related variable, i.e. clinical population, neuro-typical population, bilinguals, adults, child & infants, different genders were taken and comparisons were done. Likewise, learning situational variables is studied by manipulating the variables like introducing inferential context, direct meaningful contexts, countering context, reading activity, listening activity, and sleep variables. Similarly, the word variables are explored by introducing non-sense syllabic combinations as novel words, or foreign language words as novel words, adding contours within novel words, using different lengths and phonological complexity of words. The neural processes involved in word learning have also been explored using EEG, N400, and eye-tracking devices to see the neural activation areas while learning words. Post the training, the words are assessed through direct word elicitation tasks or forced choice tasks of recognition. In cases where word elicitation tasks were not possible, especially with kids, alternative testing tasks like intermodal preferential-looking tasks (Mani et

al., 2013), mispronunciation detection tasks (Alt & Suddart, 2012), and spatially supported forced choice recognition (Gordon & Mc Gregor, 2014) were found to be used. This decade of research on word learning has been exploring different unique variables explained below.

Weiyi & Bowers (2024) found that music aids early word learning, but its effectiveness declines with age. Upadhyay et al. (2022) showed opaque sentences hinder word acquisition in adults, pointing to gaps in metacognitive research. Neveu & Kaushanskaya (2023) discovered that Paired Associate Learning (PAL) is more effective than Cross-Situational Word Learning (CSWL). The final word elicitation task, if performed using a different picture than the training stimulus, would even tap the 'generalization variables', but such studies are scant. Bleijlevens et al. (2023) noted young children rely on pragmatic cues, Saksida et al. (2021) on prosody and stress cues, while Bulgarelli and Bergelson (2022) found talker variability impacts sensitivity to mispronunciations in the younger population. Vong et al. (2022) showed that machine learning simulations can accelerate word learning. Tsuji et al. (2022) demonstrated that real-time teaching is more effective than video calls. Gellert and Elbro (2013) highlighted that phonological and cognitive skills predict vocabulary development. Mollica and Piantaosi (2022) proposed an innovative "computational model of kinship" to understand learning and refining prototypes of kinship terms. Future research could develop similar models for other word categories. James, Gaskell et al. (2022) found that semantic density and phonological similarity affect learning. Papagno and Vallar (1992) emphasized phonological memory in word learning, while Service and Craik (1993) showed children use associative learning more than adults.

Recent studies on word learning demonstrate diverse influences on vocabulary acquisition. ERP research by Mangardich and Sabbagh (2022) highlights that pictures enhance semantic encoding, evidenced by the N400 component, while differential hemisphere activation for novel versus familiar words was found (Schimke et al., 2021). Neurological evidence for associative word learning was found through N400 and Late positive component study (Elmer et al., 2022). Bilinguals show superior verbal working memory and tolerance for phonological variations compared to monolinguals, as seen in studies by Mishra (2019). Clinical research showed better learning for animacy words in temporal degeneration cases. Clark and Reuterskiold (2023) AAC study revealed an orthographic advantage to word learning, while non-verbal cognitive advantages to learning words were found by (Josphep et al., 2023) in ASD children. Norman et al. (2022) and Broek et al. (2018, 2022) demonstrate that diverse contexts and non-contextual retrieval enhance learning, while multimodal inputs (Teng, 2022; Ramezanali & Faez, 2019) and prosodic features (Li & Benitez, 2023; Yan Gu & Shi, 2022) further support vocabulary acquisition.

Discussion and Conclusion

The past twenty years have witnessed a surge in research in the field of word learning. Investigating a word and comprehending how learning operates can be fruitful in the word and language learning domains. Around 200 studies were referred, including experimental, non-experimental, and longitudinal methodologies, focusing on word constituents, natural word acquisition, and multi-language word learning. Studies generating models and innovative theories in word learning were also incorporated, and information was compiled from different segments.

In the realm of the surveyed studies, word learning is the process of acquiring a word's form and meaning, and establishing a link of association between the word and its label. Both 'innate learning biases' and the 'active cognitive mechanisms' work together in learning words, and ultimately bring a change at the neural level. Word learning varies with age, gender, language, and environment of exposure, and modality. It is common for learners to acquire words in a step-by-step manner, starting

with the 'identification and recognition' of words at their first encounters, and the complex word knowledge, including the word's length, breadth, depth usage, patterning, and systematic word organization is acquired in later encounters. Recent research has shown that each word category has its own differential acquisition rate and might follow its unique acquisition model.

A deeper understanding of the word learning subject, through more research, could elicit the finest evidence-based training strategies for L1 and L2 learners to develop a broad, varied, and rich vocabulary that may be chosen by language instructors. This could facilitate communication and academic success, as there is a positive correlation between vocabulary with academic accomplishment and successful communication. Furthermore, with this thorough understanding of theoretical word learning and experimental research, the clinical population seeking word intervention and language therapy would also benefit.

Two issues have been noted regarding the article selection process and the information analysis in this paper. Given the unique nature of the review topic, systematic article selection using predefined criterion sample sizes could not be used for this study, since the review required theoretical constructs and some experimental studies. Though Google keyword search codes were used, the snowball selection paradigm was also employed for some topics based on relevance. Furthermore, the information is analyzed using the qualitative approach by compiling statements, instead of the quantitative approach, like meta-analysis. So, the current work is limited to being a review article, instead of a systematic review paper, following these restrictions.

The lexical organization being the ultimate phase of word learning, future research should assess word learning based on organization templates, rather than just recognition and recall. Since word learning relies on the acquisition of meaning and form equally, both semantic and phonological skills need to be highlighted during word learning, and these skills need to be explored further. More studies should be done to fill the dearth of information by examining memory, cognition, the learner's active participation, and individual differences in word learning. The multi-complex nature of words should be explored using a multifactorial research design where the active role of variables such as sleep, slow map, fast map, phonology, language similarity, age, and gender on each other in word learning is examined in future studies. The current realm of literature shows scarcity in word learning models tackling learning and forgetting together, so such an area could also be viable in future studies. Recent word usage trends indicate that acronym words and emoticons need further research.

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