

# TD Snap Motor Plan White Paper

## Introduction

The Motor Plan page set for TD Snap places a strong emphasis on language development and is targeted at emergent communicators with complex access needs. It is rooted in the presumption that users will acquire the ability to produce novel generative language for communication. The AAC user's ability to develop language and express ideas in their own words sets a foundation for the rest of their life, and to this end the Motor Plan page set seeks to support this vision.

## Basic Operation

Operationally, the Motor Plan page set follows principles frequently associated with motor planning in the context of AAC, namely, the user learns distinct motor patterns associated with each word. Over time, the user develops automaticity, allowing them to transfer cognitive effort towards generative language production and communication.

The page set is constructed such that the production of each word begins on the Home Page. From there, the user makes zero to three navigational selections before selecting a word. When the word is selected it is spoken aloud, inserted into the message window, and the user automatically returns to the Home Page, ready to select a new word. The vocabulary is organized so that the most frequently used words are closest to the Home Page. This minimizes navigation and reduces motor effort. On average, it takes 2.3 selections <sup>1</sup> to produce each word, when measured against a broad sampling of spoken English.

## Vocabulary

The page set vocabulary has been chosen to focus on core words, i.e., high-frequency words that are used across a variety of contexts. This common approach serves to support early language development while also boosting vocabulary coverage. Special attention has also been paid to fringe vocabulary that has high applicability to young children, early language learners, and early education.

The Motor Plan page set contains roughly 2,700 words, not including inflectional forms. When measured against an extensive sampling of spoken English (100 million sentences), vocabulary coverage is 88%. This means that when using the Motor Plan page set to produce any given sentence of spoken English, the page set will be missing necessary words about 12% of the time. While it is infeasible to include every word in the English language, the Motor Plan page set represents a set of carefully chosen words that provide a solid foundation for language development.

Table 1 TD Snap Motor Plan vocabulary coverage measured against commonly-referenced word lists.

Word List	Motor Plan Vocabulary Coverage
Toddler Vocabulary (26 words) [1]	100%
Preschooler's Vocabulary (331 words) [2]	97%
Dolch Sight Words (220 words) [3]	97%
Adult SGD Words (100 words) [4]	95%
Mealtime Vocabulary (347 words) [5]	93%
Fry Sight Words (1000 words) [6]	84%

Due to the distributional properties of language, further increasing the number of words in the page set yields diminishing returns in coverage [7] and risks inundating the early language learner with words that are increasingly unlikely to be relevant, while consuming valuable space. Instead, blank areas for adding custom vocabulary have been intentionally included throughout the page set. Most pages have at least a few empty positions and ample space is reserved in fringe vocabulary categories where the need for user-specific customization is more likely, e.g., People, Toys & Games, TV & Movies, and Hobbies & Leisure.

1. Selection data gathered using TD Snap Motor Plan 30 Page Set without automatic morphology.

## Grid Size

The Motor Plan page set is available in different grid size layouts, each with a different number of buttons per page. With other AAC systems, smaller button layouts are frequently associated with a larger vocabulary; however, this is not the case with the Motor Plan page set. Each version of the page set includes the exact same vocabulary, selected to provide wide coverage and a solid foundation for language development.

The different grid size layouts are designed to accommodate different access needs for individual users. Some users may require larger physical targets or lower visual complexity, while users who can manage smaller buttons gain extra space for customization and a modest improvement in navigational efficiency. It is crucial to pair each user with the version of the page set that best meets their access needs. Users should be able to comfortably visually process, identify, and activate buttons, with a minimum of accidental selections, so that they can maximally focus cognitive effort on the task of language production and communication. Once a user has invested in a particular version of the page set, changing layouts should be avoided, as this requires relearning new motor patterns associated with each word.

## Categorization

Vocabulary in the Motor Plan page set is organized by taxonomic category, grouping words by feature and function, rather than theme or context. This approach is based on an overwhelming body of widely cited research in the field of language and cognitive development, which demonstrates the tight coupling between categorization, memory, language, and conceptual development [8]. Grouping words taxonomically encourages their use across contexts. In contrast, thematic associations organize words in relation to specific events, activities, or scenarios; there is no functional or perceptual similarity in words grouped this way. While thematic groupings can be useful, organizing words taxonomically builds stronger discernible categories that provide greater benefit to the user.

There is abundant research that demonstrates children's ability to identify taxonomic categories from a very young age [9] [10]. Grouping words by feature and function delivers cognitive economy [11] and aids in the retrieval of words. This is particularly important during the early stages, while the user is still mapping their vocabulary. Before a user has memorized the exact position of a word, they can still easily find it on the page that groups together other words that share similar features and functions.

Each page that groups words taxonomically contains strong exemplars. These are words that share the most common features and define the central representation of the category. Exemplars help the user to identify the category [12] and accelerates learning and recall through the typicality effect [13]. The typicality effect is a well-documented phenomenon whereby people learn and identify typical items as members of a category more rapidly than atypical ones [14][15].

Organizing words into clear categories also boosts vocabulary acquisition through generalization and associative learning [16]. For example, the word submarine may be unfamiliar to the user, but exposing them to this word grouped with the other familiar vehicles provides important clues that allow them to draw valuable inferences about this novel word, e.g., it is an object that can be used to transport people from one location to another.

The category superordinate is the word that labels the category (e.g., the word animal on the Animals page). These words are made prominent through visual highlighting and occupy a consistent position on pages throughout the page set. Emphasizing the superordinate helps to define the category for the user [17][10] while also identifying it as a key word that facilitates the use of descriptive language in cases where the vocabulary omits a specific word that the user needs. For example, if the user wants to talk about an artichoke (not included in the vocabulary), they might use the superordinate "vegetable" to refer to "that vegetable" or "the vegetable that looks like a flower". Developing strategies for communicating about something that is missing from the vocabulary is of key importance for any AAC user.

Lower frequency verbs, adjectives, and adverbs are categorized alphabetically. This provides another consistent mechanism to aid recall and supports literacy development. Grouping words by their initial letter teaches and reinforces letter-sound correspondence. The acquisition of phonological knowledge is an essential early stage in literacy development.

## Morphology

It is widely recognized that children, without explicit instruction, generalize and apply morphological patterns from a very young age [18]. In fact, the strong tendency for early language learners to *over-generalize* and incorrectly apply these patterns to irregular nouns and verbs (e.g., tooth→tooths, go→goed) has long been a topic of interest in the field of child language acquisition [19][20]. The Motor Plan page set leverages the natural tendency for children to generalize morphology through the Word Forms page. The Word Forms page facilitates the production of inflectional forms of nouns, verbs, and adjectives by associating each form with a generalized motor pattern. For example, there is a single button that inflects all verbs to the past tense. Supporting morphology this way avoids presenting the user with an overwhelming

number of distinct inflectional forms for each word, provides cognitive economy, makes efficient use of space, and mirrors how language learners apply morphology.

## Layout

Buttons are displayed and arranged on each page so as to provide the user with additional visual clues and information that helps them learn and access words.

- Words on pages that form subordinate categories (e.g., days of the week, seasons, continents, oceans, etc.) are grouped together. Where appropriate, color highlighting is also used to help draw attention to these groupings.
- Adjectives that have strong semantic relationships (e.g., opposites, small/medium/large, left/middle/right, etc.) are positioned adjacent to one another to leverage associative learning further.
- To reduce motor effort, many buttons are positioned with consideration for the location of the linking button on the preceding page. For example, the most commonly used button on the Word Forms page is the -s (plural) button. Positioning this button such that it occupies the same position as the button that navigates to that page simplifies the motor plan for producing this high frequency inflection.

## Keyboard

As the user's ability to use language advances, the need to expand their vocabulary will reach a point where it becomes infeasible to continually add new words. The page set includes an accessible keyboard, intended as a tool to augment the existing vocabulary, for users who are beginning to develop spelling skills. The keyboard offers unlimited flexibility for language production. That said, words that are already supported by the page set are most efficiently produced using the built-in vocabulary. This is especially true for users who have spent time mapping their vocabulary and have developed some degree of automaticity.

## Sentence Terminators

The Connecting Words page includes sentence terminator buttons for period, question mark, and exclamation point. These special buttons are programmed to insert the associated punctuation and then speak the completed sentence. These buttons aid language development by encouraging the formation of communicative intents from sequences of words. Activating these buttons signals the end of the phrase or sentence while allowing both the user and communication peer to review the entire construction, spoken with prosody and rate comparable to that of typical speakers. This auditory feedback helps to reinforce to the user the difference between statements and questions.

The sentence terminator buttons on the Connecting Words page are meant to be introduced to the user at a stage much earlier than the keyboard. While spelling is an advanced skill, the construction of complete statements and questions should be introduced much earlier.

## Vocabulary Filter

The Vocabulary Filter is a tool that allows facilitators to easily control which words are available to the user. It can be used to incrementally grow the user's vocabulary over time, or to temporarily focus the user's attention on specific words in the context of a therapy session.

Using the Vocabulary Filter, the facilitator defines lists of words to make available. When the Vocabulary Filter is turned on, only the words in the active word list are visible to the user. Turning the Vocabulary Filter off instantly makes all words available again. Importantly, the motor patterns associated with each word remain consistent, regardless of whether the Vocabulary Filter is turned on or off. The Vocabulary Filter also includes management features that support duplicating, modifying, sharing, and importing different lists of words.

## References

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