

# A Digital Early Spelling Game: The Role of Auditory and Visual Support

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*We constructed a computer game to support preschoolers' early word spelling without an adult's assistance. The study explored the relative influence of auditory and visual digital supports on children's performance. Participants were 96 preschoolers who were randomly assigned into one of three groups: no support, auditory only support, or auditory + visual support. Children in each group played the digital game during eight meetings, and the computer recorded their activity. The auditory + visual support group scored significantly higher than the no support group on all letter tasks. We did not find significant differences between the two groups that received support, nor did we find differences between the auditory only support compared to the no support group, except for writing the last letter. The study shows that a digital game can help preschoolers progress in their spelling skills without the support of an adult. Auditory support is important, and the visual support significantly adds to children's spelling performance.*

**Keywords:** *digital spelling game, auditory and visual support, computer mediation, early childhood, literacy, technology, writing*

## Introduction

In recent years, technology has become as important a learning environment as the traditional ones (Takacs, Swart, & Bus, 2015). Using technology for learning has potential advantages, including immediate feedback to the learner and increased learner motivation, which is evident in the love many children have for digital games (McManis & Gunnewig, 2012). There is a variety of digital learning games for preschoolers, and in the current study, we focused on promoting early literacy skills using a digital word spelling game. Writing activities with preschoolers advance their phonological awareness and letter knowledge, which are central predictors of later literacy achievements (Martini & Sénéchal, 2012; Suortti & Lipponen, 2016). Moreover, there is evidence that these activities, which include phoneme to grapheme correspondence, promote reading acquisition (Gerde, Bingham, & Wasik, 2012; Jones, 2015; Levin & Aram, 2013). We constructed a game to support preschoolers' early spelling practice without an adult's assistance. We think that preschoolers in general can benefit from this game, yet we chose to study its effectiveness with preschoolers from a lower socioeconomic status (SES). It is important to promote the early literacy of preschoolers from a lower SES because they generally show lower early literacy skills

compared to children from a middle SES (e.g., Fernald, Marchman, & Weisleder, 2013; Justice & Ezell, 2001) and tend to experience fewer writing activities at home (e.g., Arafat, Korat, Aram, & Saiegh-Haddad, 2017; Phillips & Lonigan, 2009).

### *Promoting Early Literacy via Writing/Spelling Activities*

Phonological awareness and letter knowledge are primary early predictors of reading and writing acquisition (e.g., Bowles, Pentimonti, Gerde, & Montroy, 2013; Castles, Wilson, & Coltheart, 2011; Foulin, 2005; Levin, Shatil-Carmon, & Asif-Rave, 2006; Reese, Robertson, Divers, & Schaugency, 2015; Robins, Treiman, & Rosales 2014; Zhang, Hur, Diamond, & Powell, 2015). One method for promoting these skills is by supporting early writing and spelling (Levin, Aram, Tolchinsky, & McBride-Chang, 2013; NELP, 2008; Puranik & AIotaiba, 2012).

Adult-preschooler shared writing activities encourage children, through playful, meaningful activity, to analyze the sound structure of words and support phonemic segmentation and letter learning (Bingham & Mason, 2018; Gerde et al., 2012; Neumann & Neumann, 2014; Puranik & Lonigan, 2011). When practicing early writing/spelling, preschoolers frequently explore the sound-letter relationships.



Many times, they say the word to themselves slowly and write parts of it correctly and the rest with random letters (Aram, Abiri, & Elad, 2014; Jones, 2015; Levin & Bus, 2003; Treiman, 2017), for example, writing the letter *F* followed by few random letters for *father*. Gerde et al. (2012) found that children initially write the letter that represents the first sound in the word (e.g., *B* for *Bird*), then they write both the first and last sound in the word (*BD* for *Bird*), and finally they represent the consonants of the middle (*BRD* for *Bird*).

Hall, Simpson, Guo, and Wang (2015) reviewed interventions that included writing support and found them effective in promoting children's early literacy skills. In an intervention study, Levin and Aram (2013) explored the effectiveness of different types of human support given to Hebrew-speaking preschoolers during a spelling game that included: (a) segmenting a word into its sounds, consonant + vowel/consonant (CV/C), and connecting each segment to a letter; (b) naming the letters; and (c) encouraging children to practice spelling with no specific feedback. They found that the most effective feedback for promoting children's early literacy skills in Hebrew (letter knowledge, phonological awareness, writing, and word decoding) was the support of segmenting a word into its sounds (C/CV) according to the Hebrew writing system and connecting each sound to its corresponding letter. For example, the effective feedback for writing the word *delet* (door) that is written *DLT* was *de-le-t, de – dalet,<sup>1</sup> le – lamed, t – taf*. Feedback that focused solely on the names of letters promoted children's early literacy only minimally and was as effective as practicing spelling only with encouragement without any feedback.

In our digital game, in line with Gerde et al.'s (2012) findings regarding stages of spelling difficulty, each session started with spelling of the first letter of a word, then moved to the last and second letters, and ended with the spelling of the whole word. Following Levin and Aram (2013), the auditory support of word segmentation was based on the Hebrew writing system (segmentation into CV/C fragments).

#### *Learning With Digital Tools in Early Childhood*

Activities with screens are commonplace in the lives of preschoolers in Western societies (Janisse, Li, Bhavnagri, Esposito, & Stanton, 2018; Neumann, 2018), and children use a variety of digital tools (TV, computer, smartphone, tablet) on a daily basis (Sezgin, 2017). Technology has reorganized our way of living, communicating, and learning (Siemens, 2014). Educational technologies have shifted learner support from instructor control toward greater learner control (Lowyck, 2014; Siemens, 2014). These online environments are rich with information as well as visual and auditory representations (Bus, Takacs, & Kegel, 2015; Sezgin, 2017; Smeets & Bus, 2014). Digital tools can address individual differences between students, allow choice and repeated practice, help follow the learners'

progress, and teach them about their mistakes (Patchan & Puranik, 2016). Nonetheless, teachers should examine and select the software skillfully and use it in class only when it promotes learning (Huda et al., 2017; Nicholas, McKenzie, & Wells, 2017).

#### *Computer Games to Promote Preschoolers' Early Literacy Skills*

Digital games have been developed in different orthographies to promote early literacy skills and are used daily within preschools (Schmitt, Hurwitz, Duel, & Linebarger, 2018). In Holland, Van der Kooy-Hofland, Bus, and Roskos (2012) found that a computer game that focused on letters' names and sounds promoted children's early literacy skills more than listening to electronic books and had lasting effects on children's reading and writing skills even 18 months later. In Finland, the GraphoGame (GG) was developed to promote kindergartners' early literacy skills by focusing on the relationship between the letters (graphemes) and the sounds (phonemes) that relate to them (Ojanen et al., 2015; Richardson & Lyytinen, 2014). In studying the effectiveness of the GG, Ojanen and colleagues (2015) emphasize that there is a difference in reading acquisition between languages with a transparent orthography (e.g., Finnish and Zambian) and those with a deep orthography (e.g., English, French) and recommend adaptation of literacy games to the specifics of the orthography.

Accepting this recommendation, we developed a digital spelling game adapted to Hebrew—a consonantal Semitic language known as Abjad (Tadmor-Troynsky & Share, 2017). In consonantal languages, all the consonants but only some of the vowels are represented by letters. Hebrew has a deep orthography because the consonant *g* can be read as *gi, ga, ge, gu, go, or g* based on the context (Treiman, Levin, & Kessler, 2012). A child learning to write in Hebrew will first spell primarily consonants and only later will add vowels (Aram & Levin, 2001; Levin & Bus, 2003; Levin et al., 2006). There has been no research in Hebrew on how elements in digital games can promote early literacy skills (not including studies on electronic books; e.g., Korat, 2009). A review of commercial computer literacy games revealed few programs for practicing letter knowledge and phonological awareness. However, these programs did not focus on or even include spelling activities. We therefore designed a digital game that focuses on promoting children's understanding of the Hebrew writing system. We opted to study the effectiveness of different types of feedback adapted to the Hebrew orthography.

#### *The Importance of Meaningful Feedback for Promoting Learning*

There is evidence that using a computer in a learning setting without feedback does not necessarily lead to

improvements in children's achievements. For example, Plowman, McPake, and Stephen (2008) observed preschoolers' interactions with computerized communication. They found that the benefits that children derive from using the digital media without guidance or feedback can be temporary, ineffective, and inadequate. The authors argue that the content of the computerized activity or the characteristics can serve as a challenge for the children and that without meaningful support, they can fail in the activities and not reap the potential benefits.

In the area of literacy, there is also evidence for the importance of digital feedback. A study conducted in Holland (Voogt & McKenney, 2008) examined the utility of a computer program (Picto-Pal) for promoting reading and writing among 5-year-olds. The program allows for the production of written products, such as short letters or lists. The children played with the program four times over 5 weeks with no feedback. Interestingly, the researchers did not find significant differences in the reading and writing skills between this group and the comparison group that did not use the program.

In our game, we assessed the effectiveness of two types of feedback: auditory support (hearing the words segmented into CV/Cs) and auditory + visual support (each CV/C is highlighted while it is heard). The visual and auditory input channels that are frequently present in digital games raised the question of whether presenting in one or both channels simultaneously contributes to or hinders children's early literacy learning. Paivio (2014) proposed the dual coding theory, which posits that verbal (auditory) and visual information are processed by two separate but related channels. This simultaneous processing allows deep learning because the understanding of nonverbal information supports the understanding of verbal information and vice versa. However, there are studies that showed that simultaneous presentation of auditory and visual information does not significantly help and that the double contribution is dependent on the nature of the task and the student's characteristics (Takacs et al., 2015). Mayer (2009) discussed three main assumptions when learning with multimedia: (a) There are two separate channels for processing information—auditory and visual; (b) there is limited channel capacity; and (c) learning is an active process of filtering, selecting, organizing, and integrating information. Mayer suggested that the brain interprets the multimedia presentation of words, pictures (visual), and auditory information and that these elements are selected and organized dynamically to produce logical mental constructs.

In the current study, we examined the impact of auditory support for spelling along with the addition of visual support. We used auditory and visual effects that are directly related to supporting the spelling process. The auditory effect included hearing the word segmented into its components while the added visual effect highlighted the position

of each letter. To the best of our knowledge, across orthographies, this is the first study that examines the benefits of digital visual support along with auditory support in early spelling.

### *Study Aims*

We planned our study in light of Mayer's (2015) call for research-based designed educational computer games. Mayer stated that when planning a game, we must ask which features make a digital game more effective and how playing the game improves one's academic skills. We aimed to learn how various digital supports (auditory only/auditory + visual) impact children's performance on spelling tasks (first letter, last letter, second letter, whole word) and what the differences are in the rate of progress of the children who play with the different digital supports from the first to the last games.

To answer these questions, our study included three groups of preschoolers who played. The first group played the base version of the digital spelling game with no support. The second group played the game with an added feature—auditory support. When playing the game, children in this group heard the word that they had to spell segmented into its components. The third group received an extra feature—visual support. When playing the game, they heard the word segmented into its components while simultaneously seeing the highlighted position of each letter.

We hypothesized:

*Hypothesis 1:* The group playing with auditory + visual support will be more successful in the spelling tasks (first/last/second/whole word) compared to the auditory only support or no support groups.

*Hypothesis 2:* The group receiving auditory only support will be more successful on all the spelling tasks compared to the no support group.

*Hypothesis 3:* The auditory + visual support group will be more successful on the spelling tasks from the middle games compared to the auditory only and no support groups.

*Hypothesis 4:* The auditory only group will be more successful on the spelling tasks from the middle games compared to the no support group.

## **Method**

### *The Spelling Game*

The game includes a total of 195 boards. Children aim to move from board to board and collect a maximum number of points. For each board, a word with missing letter/s appears in the center of an empty screen, and above it is a picture depicting the word. A little monkey sits to the left of this picture. Four letters appear below the word, and children select the appropriate letter/s to spell the word (see Figure 1). We

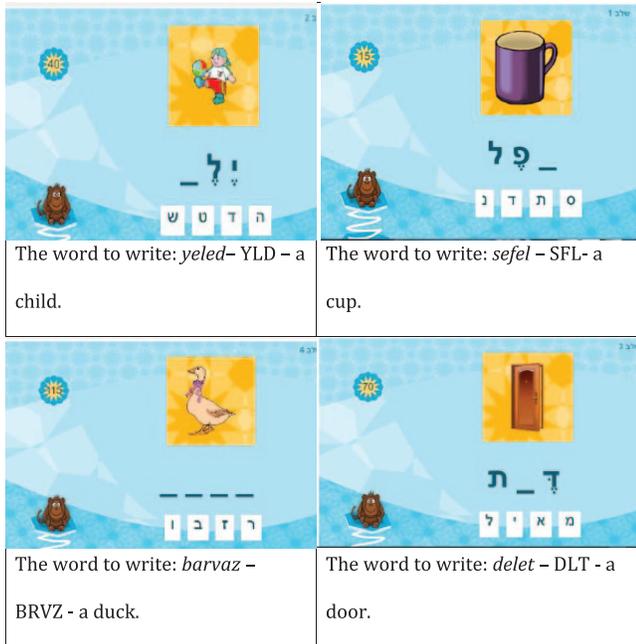


FIGURE 1 Example screens: writing the opening letter, closing letter, second letter, and complete word.

asked the children to drag the letter to the appropriate place to complete the word. Because our game is a spelling rather than a graphic game, children dragged letters and did not produce them graphically on a touch screen. Dragging the letters is easier than printing them, and this enabled encounters with more words per game. When children press on a letter, they hear its name, and when they press on a picture, they hear the word. Due to the importance of immediate feedback and reward (e.g., Kegel & Bus, 2012; Patchan & Puranik, 2016), we added a cartoon monkey that rewards the children for each correct response. If the children select the correct letter, they hear a sound of success (a chime), and the monkey hops and awards them five points. If a child selects an incorrect letter, the letter returns to its place, and the word is heard again. At the end of each level (six boards), they hear a celebration sound.

We decided to digitally name the letters when children press them because in a pilot study with 31 preschoolers from the same background, children in each of the intervention groups kept asking the researcher for the names of the letters while playing. This basic knowledge helped them make independent decisions.

Each child played the four levels of the game in each of the eight sessions. The levels of the game are adapted to the difficulty of writing: (1) writing the first letter, (2) writing the last letter, (3) writing the second letter, and (4) writing the whole word (Bowman & Treiman, 2002; Levin, Both-De Vries, Aram, & Bus, 2005). The children wrote 24 words during each session, 6 words in each level (see Figure 1).

Several elements contribute to the uniqueness of this digital game. The game is designed based on previous studies on digital games (e.g., Neumann, 2018; Richardson & Lyytinen, 2014; Van der Kooy-Hofland et al., 2012). Only one word is presented on each screen accompanied by one simple, clear picture. There is evidence that multiple pictures on the screen distract children and make the task more difficult (Falloon, 2013). The words appear in the center of a clear screen with no gimmicks or hotspots. Studies show that commercial literacy games with crowded screens tend to turn children's attention to the gimmicks instead of the literacy tasks (Bus et al., 2015; Falloon, 2013; Van der Kooy-Hofland et al., 2012). We designed the game in accordance with Hebrew orthography. The words include all the letters of the Hebrew alphabet and their various sounds. In line with the typical length of words in Hebrew, we chose two- to five-letter words with different structures. The selected words do not include vowel letters because in Hebrew, these words are more difficult for young children to write. Consonants are full-fledged letters, but vowels are not (Share & Bar-On, 2018). The auditory and visual digital supports also fit the Hebrew writing system, segmenting the words into sounds according to Hebrew writing (CV/C segments).

### Participants

The participants included 96 children (53 girls, 43 boys) who learned in five preschools located in low SES neighborhoods in Israel. Their mean age was 5.7 years ( $M = 69.08$  months;  $SD = 4.28$ ). Only 27.84% of the participants' mothers and 22.08% of the participants' fathers hold an academic degree, whereas on average, 46% of the Israeli adults hold an academic degree (Central Bureau of Statistics, 2016). All the children were in the last year of preschool before moving to school. Children who were absent for more than 2 weeks during the intervention as a result of illness (two children) and those who had lived in Israel for less than 2 years (four children) were excluded from the study. The teachers in all five kindergartens reported that they implement class literacy activities (mainly singing letters songs, letter naming activities, and sharing books with the children) but not writing or reading activities.

### Procedure

The study took place over 5 weeks in each preschool. It received the approval of the Israeli Ministry of Education and Tel-Aviv University. The parents signed consent forms prior to the beginning of the study. The researcher came to the preschools during the first week and assessed the children's word spelling. During the second through fifth weeks, the researcher came to the preschool with four laptops (including headphones) and an Internet connection. The preschool routine was kept, and the researcher called four

children at a time to play the digital game in a quiet area. The teachers were not involved and were blind to the study's nature and the children's placement in the different groups until the end of the study.

In each preschool, the researcher randomly assigned the children into one of the three intervention groups: (a) no support: children played the game without support—the picture appeared on the screen while the word was heard ( $n = 31$ ); (2) auditory only support: the picture appeared on the screen and the word was heard. Then, the word was heard again segmented into CV/Cs according to the Hebrew orthography (e.g., sefel [a mug] is written SFL and was heard /se/fe/l) ( $n = 32$ ); and (c) auditory + visual support: The picture appeared on the screen, and the word was heard. Then, the word was heard again segmented into CV/Cs while the position of each letter was concurrently highlighted when the sound was heard (e.g., when the sound /se/ was heard the place for its letter was highlighted;  $n = 33$ ).

The intervention included eight 20-minute sessions with the spelling game, on an individual basis, over the course of 4 weeks (twice per week). Prior to the first session, the researcher practiced the use of the mouse with each child in the intervention groups (10 minutes). For this practice, she used a game where the child had to drag toys into a box (i.e., dragging the letters to spell the word). Afterwards, she explained how to play the game for each child individually according to his or her group. The researcher only assisted them in solving technical issues (e.g., accidentally leaving the game). At the end of the study, the researcher met with each preschool teacher and showed her the game with the different types of feedback and explained the study.

### Measures

In every group, each child played four levels in each of the eight sessions. In each session, the child spelled a total of 49 first letters, 49 last letters, 50 second letters, and 46 whole words. The computer tracked the children's successes and mistakes in choosing the letters across each level and session.

Our analysis of the children's letter choices focuses on the first letter that they chose. A success was recorded when the child picked the correct letter on the first try, with the assumption that if the child succeeded on the first try it was due to an informed choice rather than a guess.

1. Choice of first/last/second letter: The child received one point if he or she correctly selected the correct letter on the first try and a zero if not. Each child received a score that reflects the percentage of success for each of the eight games played (24 scores—eight scores for each of the four levels).
2. Full word: The child received a score showing the percentage of success in spelling each word during

each of the eight games. The score for each word was the percentage of the total number of letters that had to be selected (eight scores in total).

*Spelling level* (Levin & Aram, 2012). To compare between the groups prior to the intervention, we asked the children to spell eight words (different from the words in the game), each on a separate sheet of paper. The words were comprised of a total of 42 letters and included all 22 letters of the Hebrew alphabet (including final and vowel letters). For each letter, we used a 5-point scale for assessing the spelling level: (0) random letter, (1) a homophonic letter in an incorrect position, (2) a correct letter in an incorrect position, (3) a homophonic letter in a correct position, and (4) a correct letter in a correct position. The average score across the 42 letters served as the spelling level score. Internal reliability between the letters was Cronbach's  $\alpha = .95$ .

## Results

This section describes the children's use of the game. First, we detail and compare the different groups' spelling level prior to the intervention. Following this, we present the ANOVAs revealing the impact of the various digital supports on children's selection of first/last/second letters and whole word based on group. Last, we evaluate children's progress from the first to last game based on group.

### Children's Spelling Pre-Intervention

We compared children's word spelling in the three groups prior to the intervention. Children's mean scores were 0.54 ( $SD = 0.66$ ), 0.56 ( $SD = 0.77$ ), and 0.56 ( $SD = 0.76$ ) for the auditory + visual support, auditory only, and no support intervention groups, respectively, with no significant differences between them,  $F = 0.03$ ,  $p = .991$ . Results revealed that overall, the children wrote very few correct letters. Most of the children wrote using random letters.

### Comparison of Spelling Success Using Various Digital Supports

We used ANOVAs for independent samples to evaluate the most effective digital support for children during the game and learn which support contributes to greater spelling success on first/last/second letter and whole word. Table 1 shows the means, standard deviations, and ANOVAs for the various spelling tasks by group.

It can be seen (Table 1) that the auditory + visual support group scored higher than the auditory only group, which itself was higher than the no support group on each of the spelling tasks. The differences between the groups were significant for all the spelling tasks with the exception of the first letter.

TABLE 1

*Averages in Percentages, Standard Deviations, and Differences in Spelling Tasks by Group (N = 96)*

	No support (n = 31)		Auditory only support (n = 32)		Auditory + visual support (n = 33)		F	$\mu^2$
	M	SD	M	SD	M	SD		
First letter	51.94	22.76	58.10	22.07	64.70	18.88	2.60	0.05
Last letter	38.44	19.48	52.93	22.32	60.17	19.75	9.20***	0.16
Second letter	36.77	19.37	43.75	21.16	51.45	19.50	4.30*	0.08
Whole word	37.32	20.43	46.62	22.26	51.44	20.98	3.63*	0.07

\*\*\* $p < .001$ .

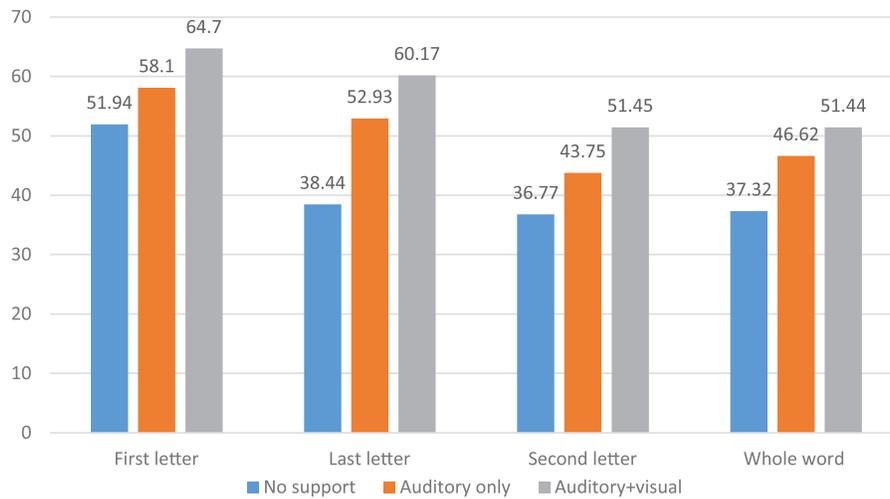


FIGURE 2. *Children's success at spelling tasks by group (N = 96).*

An examination of the source of the differences between the groups showed that while no significant differences were found for the first letter task, the auditory + visual group scored higher than the no support group in the direction of significance ( $p = .07$ ). For the last letter task, the two groups that received support scored significantly higher than the no support group, but there was no significant difference between the scores of the two groups receiving support. On the second letter and the entire word tasks, the auditory + visual support group scored significantly higher than the no support group, and there was no significant difference between the two groups receiving support. Figure 2 presents children's success at spelling tasks by group.

#### *Between-Group Comparisons Across Stages in the Eight Games*

To learn about the impact of the various types of support during the computer game, we conducted ANOVAs for independent samples between the three intervention groups for each of the stages (first letter, last letter, second letter, whole

word) in the eight games. To compare each group's success at the beginning, middle, and end of the intervention, each child was given an average summary score in percentages for Game 1, Games 2 and 3, Games 4 through 6, and Games 7 and 8. We opted for this division because at the first game, the children were playing for the first time and received explanations and support for how to play the game. In the remaining games, the children played the game independently. Table 2 presents the descriptive statistics of the children's success in spelling the first letter, last letter, second letter, and whole word in Game 1, Games 2 and 3, Games 4 through 6, and Games 7 and 8 and the comparison between them.

Table 2 reveals that for the first letter task, there were differences between the three groups only at the last two games, while for the last letter, there were differences already apparent at the first game. For the second letter task, there were differences starting from Games 2 and 3, and for the whole word, there were differences from the middle games.

In examining the sources of the differences, we learned about the effectiveness of the supports. We found that even in the first games (1–3) the auditory + visual support group

TABLE 2

*Averages in Percentages, Standard Deviations, and Differences in Spelling Tasks by Group Across Eight Game Levels (N = 96)*

	No support (n = 31)		Auditory only support (n = 32)		Auditory + visual support (n = 33)		F
	M	SD	M	SD	M	SD	
First letter							
Game 1	51.05	5.40	57.29	5.31	62.12	5.23	1.08
Play 2 and 3	47.65	4.09	51.61	4.16	57.32	4.03	1.43
Play 4–6	52.69	4.24	60.76	4.17	64.98	4.11	2.23
Play 7 and 8	51.61	4.68	64.42	4.60	69.93	4.53	4.13**
Last letter							
Play 1	35.48	4.88	50.00	4.80	52.02	4.73	3.48*
Play 2 and 3	37.19	4.10	47.13	4.03	52.02	3.97	3.48*
Play 4–6	39.69	4.34	56.08	4.27	63.47	4.20	8.05***
Play 7 and 8	38.96	4.17	55.29	4.11	66.90	4.05	11.61***
Second letter							
Play 1	33.87	5.14	31.25	5.06	43.43	4.98	1.63
Play 2 and 3	34.94	4.02	37.24	3.96	48.74	3.90	3.51*
Play 4–6	38.35	4.02	45.31	3.96	52.36	3.90	3.13*
Play 7 and 8	37.56	4.04	52.68	3.97	56.06	3.91	6.07**
Whole word							
Play 1	34.71	4.57	36.09	4.50	45.19	4.43	1.62
Play 2 and 3	38.73	4.30	42.06	4.23	47.27	4.16	1.19
Play 4–6	39.73	3.89	49.76	3.82	52.08	3.77	2.90^
Play 7 and 8	34.13	4.21	50.67	4.14	56.37	4.08	7.69***

^ $p < .06$ . \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

started showing significantly higher achievement than the no support group on the last letter and second letter levels (except Game 1 for the second letter). In the middle games (4–6), the auditory + visual group scored significantly higher than the no support group on all the levels (except for first letter), while in the last games (7 and 8), they scored significantly higher than the no support group on all the levels. Regarding the auditory only group, from the middle games, they showed an advantage in the last letter level over the no support group. In the last games (7 and 8), they show significantly higher scores than the no support group for all the levels except for the first letter level.

It is important to note that there were no significant differences found between the auditory + visual support group and the auditory only group. In sum, children who received support (auditory only or auditory + visual) progressed more than the children who did not receive support, such that at Games 7 and 8, they showed significantly higher achievement than the no support group on all the spelling levels.

### Discussion

The study explored the impact of different digital supports on children's performance while playing a Hebrew

spelling game, focusing on the effectiveness of auditory and visual supports.

#### *Comparing Children's Spelling Success With Digital Supports*

We hypothesized that the group that would play with auditory + visual support would outperform the auditory only group and the no support group on all the letter tasks (first/last/second/whole word). We also hypothesized that the auditory only group would outperform the no support group. In accordance with these hypotheses, we found that the auditory + visual group scored significantly higher than the no support group on all the spelling levels except for the first level (which tended toward significance). In contrast with our expectations, there were no significant differences between the two groups receiving support and no differences between the auditory only group and the no support group except for the last letter task.

We did not find differences between the groups in children's spelling of the first letter in the words. It would seem that the support was less helpful for this task and that the children are able to independently succeed in spelling the opening letter. Studies that have examined written spelling

tasks (pen and paper or the like) in different languages show that the first letter is the easiest one for children to identify and write (English: Bingham, Quinn, & Gerde, 2017; Zhang, Diamond, & Powell, 2019; French: Bouchière, Ponce, & Foulin, 2010; Dutch: Van der Kooy-Hofland et al., 2012). As such, it would seem that children are able to succeed in this task even without support. A study conducted in Hebrew among preschoolers from a low SES also found that the first letter was easier for children to identify than the last letter (Levin, 2010).

Our results showed that auditory support is meaningful and there is added value to including visual support in spelling tasks. Although significant differences were not found for most of the tasks between the auditory only group and the no support group, there were significant differences found when visual support was added to the auditory. The study emphasizes the importance of dividing words into sounds according to the Hebrew orthography to promote spelling. Dividing the words into the written sounds (CV/C) helps the child think about the writing process and how to convert the sound to a letter (Levin & Aram, 2013; Neumann & Neuman, 2014). Our study's results support previous studies that highlight the importance of phonological awareness to writing/spelling development (Jones, 2015). In our opinion, the addition of the visual to the auditory support promoted children's accelerated learning by helping children focus their attention, concentrate on the place of the consonant/vowel in the word while it was heard, and connect between the sounds of the CV/C and its appropriate place in the word.

The contribution of combined supports has been examined primarily in electronic books (Korat & Falk, 2017; Takacs et al., 2015). Ben-Shabbat and Korat (2017) examined the impact of visual support (expanded content using pictures and animations) and auditory support (quiet background music) while reading an e-book on the story comprehension and reconstruction of preschoolers from a low SES. The authors found that children who received both supports progressed more than children who received only one type or no support at all. Takacs and colleagues (2015) explain that in e-books with the animation enabled, the temporal contiguity principle of the multimedia learning theory predicts deeper learning when auditory information and visual information is presented together. The reason for this is that the visual information supports the auditory information in a meaningful way, illustrates it, and thereby improves comprehension. Studies on e-books also found that animation support increases children's comprehension of the book (Smeets & Bus, 2014; Takacs & Bus, 2016).

Takacs and colleagues (2015) note that visual support that is more appropriate to the textual content of the story has a greater impact on children's story comprehension and learning of new words. Moody, Justice, and Cabell (2010) discuss the importance of the number of supports when reading an e-book and believe that children's attention while

listening to stories is higher when there is animation because there is visual stimulation at the same time as auditory stimulation and the child is thus more focused and learns and progresses more. In our study, both supports were well matched as the visual support was presented concurrently with the auditory. This likely helps explain the advantage shown by the auditory + visual support group on most of the spelling tasks.

#### *Comparing Spelling at the Different Levels Between the Three Groups*

Already from the first or the middle games (except the first letter), we found that the auditory + visual support group scored significantly higher than the no support group. In contrast, the advantage of the auditory only group over the no support group was evident only from the middle to last games. At the same time, no significant differences were found at any of the levels between the auditory + visual group and the auditory only group. From these findings, we can see that progress from one game to the next is quite meaningful, particularly when the child receives support compared to the child who does not receive support. In contrast to the game without support, when there are two types of support, there is meaningful progress from the initial games, and when there is only one type of support, there is progress from the middle games.

It is interesting to note that when comparing the auditory only group to the auditory + visual group that there is progress evident even in the auditory only group. To learn and make progress, children do not need many games or very complicated games. A game with supports that are in line with the structure of the language can enable a preschooler to progress in spelling words after only a few times playing the game. A computer game can thus serve as a meaningful learning tool along with the work that an adult does with a child. Although they cannot replace adult-child literacy interactions, digital literacy games such as the one in our study can support and enhance children's experiences with literacy in the preschool.

#### *Children's Activities With a Computer: Digital Versus Human Support*

In our study, we found that digital support (auditory only or auditory + visual) greatly helped the children. There are those who contend that adult support is necessary to help young children progress when using a computer, in addition to their independent computer activities (Bus et al., 2015; Plowman et al., 2008; Segal-Drori, Korat, Shamir, & Koen, 2010; Segers & Verhoeven, 2005; Voogt & McKenney, 2008). These researchers feel that digital support is not sufficient and human support for preschoolers using the computer promotes quality learning that is appropriate to the child's cognitive and emotional level. Plowman and colleagues (2008) claim that the

content of a digital activity or the characteristics of the activity can serve as a significant challenge for children; without the support of an adult, children can fail or not receive the potential benefits. Along similar lines, Bus and colleagues (2015) argue that a digital literacy game can promote preschoolers' literacy but that adding the adult into the interaction between the child and the computer is critical for learning and progress.

While we recognize the importance of a supporting adult, individualized learning in line with the child's abilities is less practical in classes where there is only one teacher and many students. Patchan and Puranik (2016) examined how technology, particularly the computer, can be used to provide individualized learning for each child. They found that appropriate and direct feedback at each stage of learning can help the child progress. Kegel and Bus (2012) found that 4-year-old children playing an early literacy game benefited from the digital feedback of a human voice. After their first mistake, the voice told them to "listen carefully"; after the second mistake, the program provided oral hints to focus them on the task; after the third mistake, the program provided the correct answer with an explanation.

The current study's results demonstrate that digital auditory support with the addition of visual support that is appropriate for the structure of the Hebrew language can be used to help children succeed and progress even without the help of an adult. This line of orthographic-specific games can add to teachers' activities and guidance. In preschool classes, where teachers have so much to do and little time to attend to children individually or children need some extra practice, they can practice spelling independently and receive appropriate feedback. Furthermore, teachers can follow children's activity logs and thus learn about their progress and difficulties. Having this knowledge, they can support children more precisely and efficiently by focusing on the areas in which the children need more explanations.

### Conclusions

The children in our study played the game only eight times. It is important to investigate whether they would continue to progress if they played the game for a longer period. We recommend examining the effectiveness of the game with auditory and visual digital supports with a broader sample of children from varying ages and SES. It will be interesting to see whether younger children can enjoy and learn from the game and similarly whether first graders can also learn from it and progress in their reading and writing skills. Beyond this, the children in the study were able to hear the names of the letters when they pressed on the letter. It would be interesting to conduct the study with an intervention group that did not receive this support. We found the visual support to be a meaningful addition to the auditory support. It would be helpful to learn about its

independent contribution without the auditory support. In conclusion, the study shows that children using a computer spelling game adapted to the Hebrew orthography with effective auditory + visual support can promote their spelling without the need for an adult's support. Learning from a computer saves time and resources, and children can progress independently according to his or her literacy level.

### Note

1. Letter name

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