

The benefit of orthographic word connectivity on words recognition in Egyptian Down syndrome child

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Abstract

While children with Down syndrome (DS) often struggle with speaking and expressing themselves, learning to read might be helpful. Interestingly, their vocabulary seems to develop better than other speaking skills. However, they may have trouble learning the phonological form of spoken words. Cannella-Malone et al. (٢٠١٥).

This study assessed the efficiency of orthographic support on spoken word recognition. The study was carried out on fifteen Egyptian girls with DS between ٧ and ١٠ years old. The girls learned words better when they saw them written down in the presence of orthography. This suggests that even though these children have DS, they can still benefit from learning with written words, just like typically developing children.

In conclusion, orthographic support while learning new words helped children with DS to remember and recognize those words better. Even though children with Down syndrome might have trouble with spoken sounds, they can still learn new words effectively by seeing them written down. Castles et al. (٢٠٠٥)

Keywords: Down syndrome, intellectual disability, letter–sound correspondence, word recognition

Introduction

Down syndrome population

Down syndrome (DS) affects roughly one out of every ٨٠٠ newborns. An estimated ١.٦ million children in Egypt are born with DS annually, with an additional estimated risk of ٢٢٨٥ DS births each year. This syndrome occurs due to error in cell division or presence of an extra copy of chromosome, resulting in a total of ٤٧ chromosomes (Becky L. Spivey, M.Ed, ٢٠٠٦).

The normal number of chromosomes in human cells is ٤٦, arranged in ٢٣ pairs. Having an abnormal number of chromosomes, either too many or extra pieces, disrupts the development of the body. This can cause physical differences, problems with thinking and learning, and intellectual challenges like mental retardation and memory or language difficulties.

Children with DS typically develop at a slower rate than other children. They might take longer time to reach developmental milestones than their normal peers, and their physical and mental abilities may progress more slowly as well.

Most children with DS have mild to moderate mental retardation, but their actual IQ scores can vary a lot. Their physical development is also slower than usual because their muscles are weak and loose (hypotonia). This makes babies with DS learn to sit up, crawl, and walk much later compared to other normal children.

Providing an enriching home environment, early intervention when needed, and integrated educational efforts will affect the child's development positively.

DS is caused due to a random error during cell division that results in an extra copy of chromosome ٢١. According to previous research, DS results from three main types of chromosomal abnormalities. The most common, affecting roughly ٩٥% of cases, is complete trisomy ٢١. The remaining ٥% of DS cases stem from either mosaic trisomy ٢١ or translocation trisomy ٢١.

Speech and language intelligibility

Speech intelligibility is a common challenge faced by people with DS, regardless of age. There are several factors that can contribute to speech intelligibility problems including articulation problems with certain sounds, weak facial and oral muscles, leaving sounds out of words, problems with using senses together, and difficulty planning how to move their mouth for speech.

Children with DS often understand things better than they can talk about them. This shows higher test scores for receptive language than for expressive language. This difference is called the receptive-expressive gap (Abbeduto et al., ٢٠٠٧).

Research studies and clinical experience revealed that children with DS tend to struggle more with certain areas of language, while other areas are relatively easier. Syntax and morphology including grammar learning, word endings, and tenses, are more difficult areas due to their complex and abstract nature so they tend to talk using keywords rather than complete sentences. As a result, learners might rely on memorizing keywords instead of full sentences and this may be compromised by a weakness in short-term memory. Chapman, R. (٢٠٠٣).

Children with DS have strengths in the area of vocabulary and pragmatics. They have good social interactive skills and can use facial expressions and gestures effectively to help them communicate (Chapman, R., ٢٠٠٣).

Linking sounds with letters or groups of letters (graphemes)

Children with DS learn well through visual means and the use of computer programs designed for language development. This is because seeing written words alongside pictures that match the sounds, and eventually being able to read those words themselves, helps them improve their speaking and language skills.

Early teaching of sounds is effective for children with DS. Children should learn about sounds from an early stage, beginning with learning letter names and sounds, and how they combine in words is a strong foundation. This includes recognizing sounds within words, speaking single words, and progressing to longer and more complex sentences.

Even if someone can hear sounds and understand individual sounds, their ability to produce those sounds themselves, recognize them as isolated sounds, say single words, words of different length and complexity, and sentences will vary.

The starting points and progress rates, as well as the stage at which the learner will begin to use sound skills vary between individuals. Children with DS learn sound skills more slowly than the majority of pupils.

Teaching linking sounds with letters or groups of letters may help speech perception, spelling, reading, writing, and speech production. This could also boost their ability to understand complex language by helping them recognize grammatical structures, learn the rules of grammar, and be more aware of the sounds they use when speaking and writing (Cohen et al., ٢٠٠٨). Fortunately, researchers have reported that specific approaches for teaching literacy skills revealed improvements in the reading abilities for students with DS (Cohen et al. ٢٠٠٨; Waugh et al., ٢٠٠٩; Lemons et al., ٢٠١٨).

Language can be challenging for students with DS (Chapman and Hesketh, ٢٠٠٠; Chapman ٢٠٠٣). In the past, some researchers have used teaching reading by memorizing whole words. However, recent studies showed that this method might hinder students' grapheme-phoneme knowledge to decode unfamiliar words (Loveall and Barton-Hulsey, ٢٠٢١). Research shows that focusing on phoneme and phonological awareness can significantly improve reading skills in children with DS (Lemons et al., ٢٠١٨; Loveall and Barton-Hulsey, ٢٠٢١)

Spelling Instruction for Students with Down Syndrome

Students with DS can benefit from reading programs that go beyond just learning phonics. It has been reported that effective writing instruction can lead to improvements in reading skills. Both reading and writing are practical activities that increase thinking and communication skills to enhance comprehension of a specific topic (Graham and Hebert, ٢٠١٠). Some strategies are used to boost reading and writing skills including writing story summaries, teaching text structure to enhance comprehension, teaching spelling for smoother reading, and practicing writing more often

(Graham and Hebert, ٢٠١٠). Literacy instruction in schools doesn't focus enough on orthographic processing (Channell et al., ٢٠١٢). Spelling is an early literacy skill that is closely related to reading development (Graham and Santangelo, ٢٠١٤; Santoro et al., ٢٠٠٦). It is an important skill as it affects the development of phonological awareness, alphabetic skills, and letter-sound correspondence (Graham et al., ٢٠٠٢; Santoro et al., ٢٠٠٦). Phonological and phonemic awareness are used in both reading and spelling. Studies showed that spelling instruction can improve word reading skills (Graham and Hebert, ٢٠١٠). It has been reported that phonics and phonological awareness ability of students with DS can be increased when paired with spelling instruction (Santoro et al., ٢٠٠٦). Moreover, manipulation, recognition, and transfer of sounds are necessary to be an adequate speller (Berninger et al., ١٩٩٨). Spelling goes beyond simply memorizing how words look. While it isn't usually a subject on its own, spelling is a complex skill that requires proper instruction to develop. Some teachers focus on memorizing lists of words for spelling instead of teaching the phoneme patterns and orthographic letter sequences. This can make it harder for students to learn how to spell new words on their own (Moats, ١٩٨٤). Students with DS struggle with spelling due to challenges with phonological awareness, working memory, and phonemic awareness (Graham et al., ٢٠٠٢; Santoro et al., ٢٠٠٦). Therefore, students with DS need special and explicit spelling instruction to meet their needs such as identification of spelling patterns and letter-sound knowledge.

Students start by learning alphabet knowledge, phonemic awareness, and phonological awareness to transfer their knowledge to orthography (Graham et al., ٢٠٠٢; Santoro et al., ٢٠٠٦). Students who have trouble spelling can sound out the words they're writing. This helps them connect the letters to the sounds they make, which is important for reading as well (Graham et al., ٢٠٠٢). Teaching the connection between letters and phonics strengthens this link in students' minds, and using these skills in spelling improves accuracy and reduces mental effort (Santoro et al., ٢٠٠٦; Graham et al., ٢٠٠٢). Explicit spelling instruction improves reading and spelling fluency (Berninger et al., ١٩٩٨; Santoro et al., ٢٠٠٦). This is especially important

for students with DS to develop their literacy skills. Learning to spell specific words may even help them improve spelling in general.

Teaching letter sounds with specific words helps students with DS learn to read and spell new words (Graham et al., ٢٠٠٢). This approach is more effective than indirect teaching (O'Connor and Jenkinds, ١٩٩٥). While DS students might struggle with new letter patterns (Loveall and Conners, ٢٠١٦), sufficient exposure to written words can help them succeed. Developing phonological awareness and orthographic knowledge helps students to link such knowledge and can read and spell new words through decoding (Berninger et al., ١٩٩٨). More research is needed to confirm the full benefits of this method (Berninger et al., ١٩٩٨; Loveall and Conners, ٢٠١٦; O'Connor and Jenkins, ١٩٩٥).

Method

Participants

Fifteen mild to moderate Down syndrome females aged from ٧ to ١٠ years old participated in this study. An IQ test was conducted on the children to determine if they had an intellectual disability (IQ = ٤٩, ٨٠).

They were chosen from same social class and from same therapeutic clinic.

They started speech and language sessions at nearly the same year (٢٠٠٦-٢٠٠٧) and they have some other skills like (drawing, computer skills, communication and pragmatic skills).

Tools

Letter–picture cards, naming and circle the letters, and tracing for teaching reading Arabic letters were presented in this study. Appendix II.

Speech materials

Only six target Arabic consonants were chosen (/ج/, /ك/, /م/, /ف/, /ت/, /ب/). They were presented initially in different words with different Arabic vowels. See appendix I for words list.

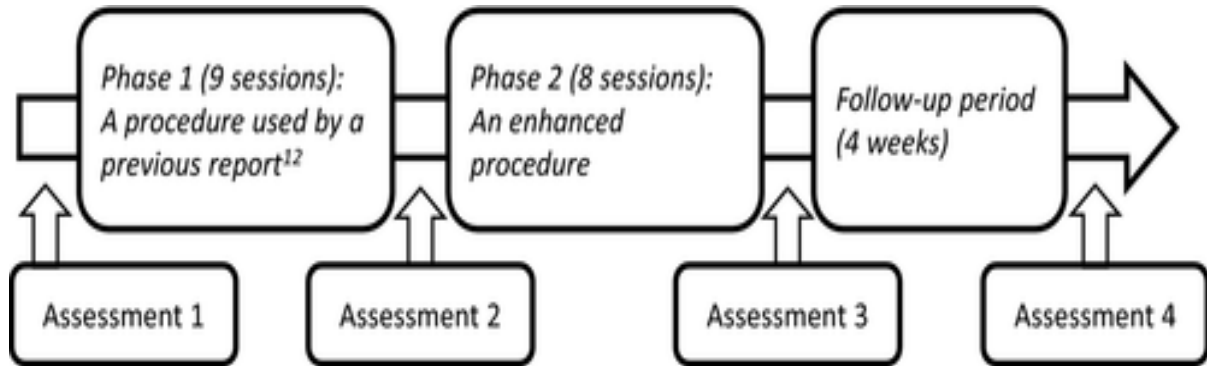
The reason for choosing these Arabic consonants in initial position that they are the earlier acquired consonant sounds in Arabic language and they are easily articulated and easily to teach. Harrel (٢٠١١)

Assessment

To evaluate letter knowledge, the child was presented with a card with a consonant on it and then asked to repeat each letter aloud (٦ consonants). The chosen consonants were obviously detected due to their clear place of articulation.

The number of correctly read letters was determined to be the outcome. Some participants were able to repeat the ٦ sounds, other failed before the stage of intervention.

Evaluation of the performance of the participants was done four times: before the intervention, after the first phase of intervention, after the second phase of intervention, and during follow-up (Figure ١).



(Figure ١).

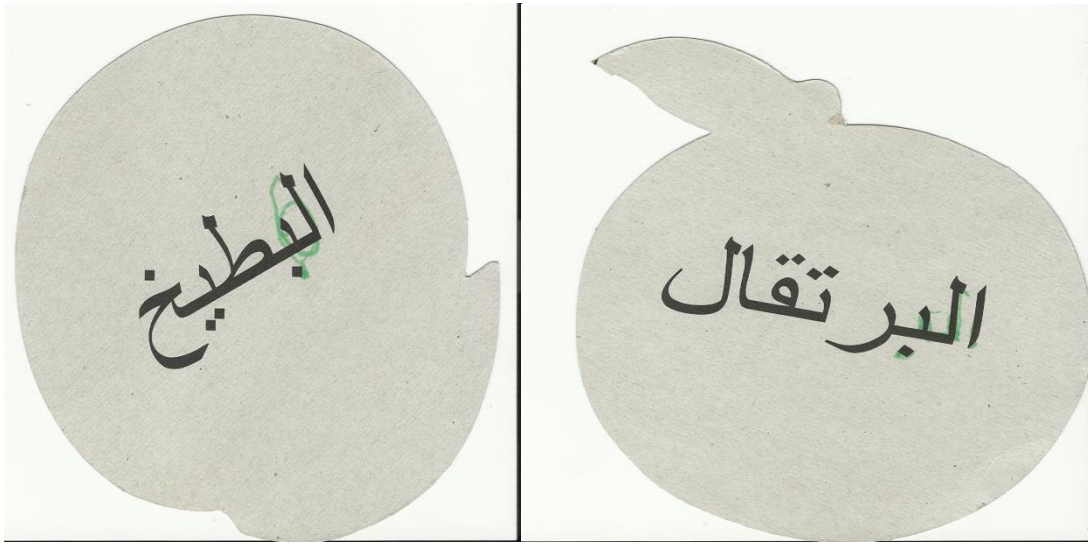
Intervention

The intervention was divided into two phases. Intervention in the first phase (٩ sessions). The tasks aimed to help children with DS learn effectively using pictures and to pay close attention to how letters look. The tasks include letter naming with flash cards, tracing, and recognizing the right consonant. (Figure ٢). In the letter naming task, cards that had pictures on the front and a consonant beside it were used. In the tracing task, the participants were required to trace over the letter with a pencil and imitate writing it down.



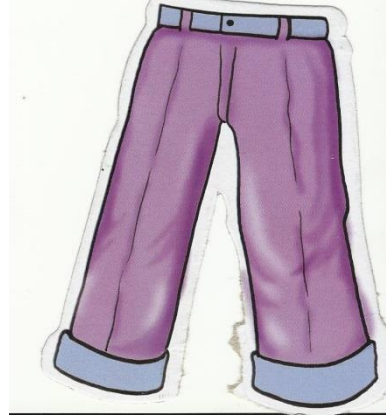
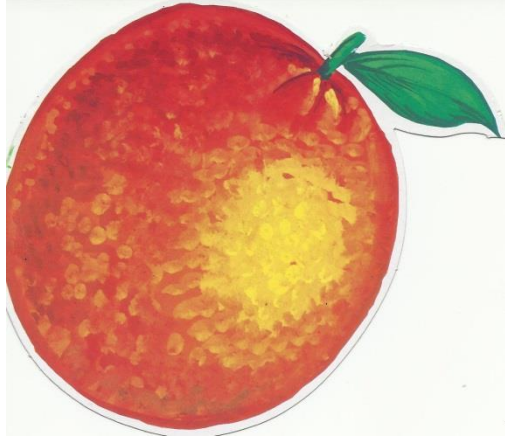
(Figure ٢)

In the Intervention in second phase (\wedge sessions), the participants were asked to complete two additional tasks to improve their learning in letter–sound correspondence. *The first task* required them to be able to distinguish the correct consonant in an Arabic word and put a circle around it. This was performed after determining the needed sound by pronunciation. Different Arabic words were selected (mono or di or multisyllabic familiar words). For example .the child was asked to distinguish and circle the /ب/ in a word like /البطيخ/. (Figure ٣.)



(Figure ٣.)

The second task is to show them cards or picture and they pronounced first and determine the correct consonant in this picture. (Figure ٤) This was a main reason why we put these sounds initially to be recognized and perceive well.



Follow-up period

The intervention materials were distributed to participants and their families following the completion of phase two. The participants used the materials several times per week during the ٤-week follow-up period. Letter knowledge was evaluated ٤ weeks following the end of the second phase intervention (Figure ١).

Results

Quantitative Results

The children of the study are evaluated on their ability to learn spoken words with and without orthographic support.

The quantitative results of this study are as follows:

١. Pre-Intervention Assessment: The initial assessment (Assessment ١) involved evaluating the children's ability to recognize and repeat six target Arabic consonants (/ج/، /ك/، /م/، /ف/، /ت/، /ب/) before any intervention was applied. The results showed varied performance among the participants, with some children able to repeat all six sounds correctly, while others struggled.

٢. Post-Intervention Assessments: Following the intervention, which involved training the children using letter-picture cards and other orthographic support tools, the children's performance was re-evaluated at multiple phases.

- *Assessment ٢*: The second step after the first phase of the intervention.
- *Assessment ٣*: The third step after the second phase of the intervention.
- *Assessment ٤*: A follow-up period to measure retention.

The number of letters correctly read by the children increased significantly after each phase of the intervention. The results indicate that all studied children showed an improvement in picture naming post-tests when words were trained in the presence of orthography.

٣. Statistical Analysis: Statistical analysis revealed a significant improvement in word learning accuracy and retention. See Table ١ and Figure ١ and ٢

Assessment phase	Mean	Standard deviation
Assessment ١	٣.٢	١.١
Assessment ٢	٤.٥	٠.٩
Assessment ٣	٥.٣	٠.٦
Assessment ٤ (follow - up)	٥.١	٠.٧

Table ١: Statistical Analysis of Letter Recognition

This table provides the mean scores and standard deviations for the letter recognition task at each assessment stage, highlighting the significant improvement in performance following the intervention.

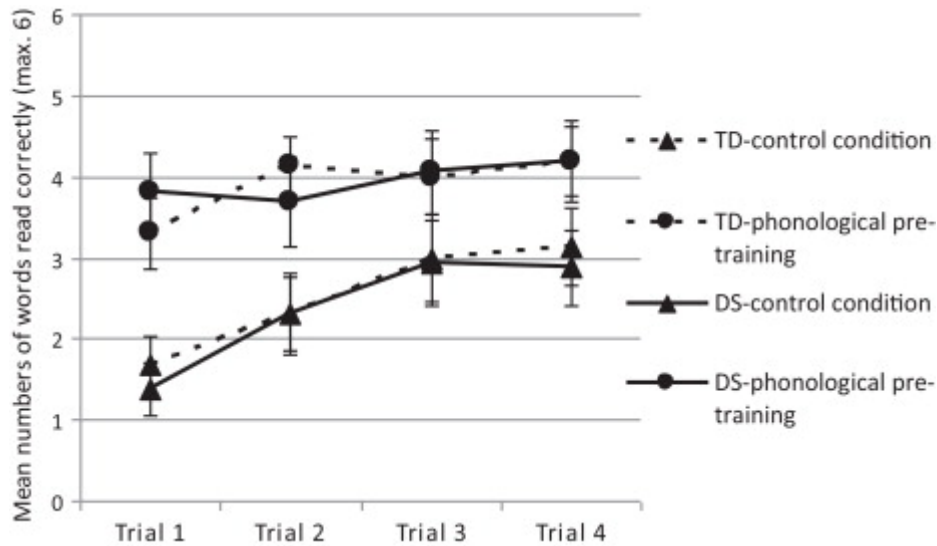


Figure ١: The mean number words recognized correctly by the Down children in each assessment phase and trial.

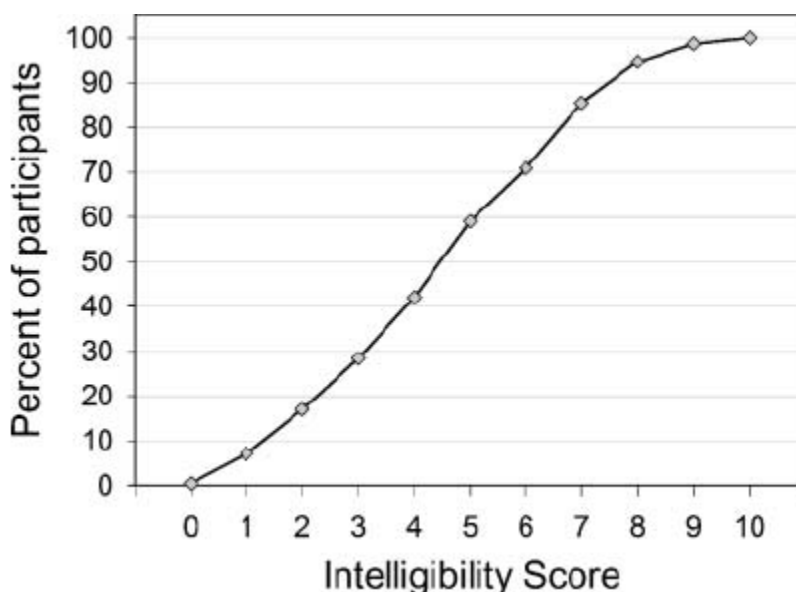


Figure ٢: The number of words recognized correctly by the children increased significantly after each phase of the intervention.

Qualitative Results

The qualitative analysis includes:

١. **Engagement and Motivation:** Teachers reported that children were more enthusiastic and willing to participate in activities that included visual aids and orthographic cues.
٢. **Confidence:** Children showed increased confidence in their ability to learn and recognize new words.
٣. **Feedback from Educators:** Positive feedback regarding the use of orthographic support was given from educators. They noted that children with DS were not specifically impaired in phonological learning and by training and good plan of treatment they benefit from orthographic support compared to typically developing children.

Discussion

The present results suggest that procedure of the second phase includes the two tasks improved the understanding of letter knowledge in a child with DS; in a comparison to the previous study of Nagayama et al. (٢٠١٠) the procedure in the first phase did not improve letter knowledge. The difference in results between the two studies might be because the children involved had different levels of intellectual ability. In other words, a child's intellectual function could influence how well they learn letter-sound connections or develop language skills Rachel et al. (٢٠١٩). Furthermore, IQ is considered as a major performance predictor in word decoding in DS.

Factors beyond the measured aspects of language, such as receptive language, may be another possible factor.

Strong language skills early on can help children learn letters more easily. This means that children with intellectual disabilities, who may have trouble developing language skills, might need extra help understanding how letters correspond to sounds in their language. The way information is presented (like using pictures or games) can also affect how well children learn this skill.

Most research studies indicate that the efficacy of interventions for language development in DS have focused on English-speaking children. If we look at studies in other languages, especially those that aren't European, phonics instruction might be more helpful than currently thought. This is because developing language skills is influenced by the language characteristics (Levy Y. (٢٠١١))

Regarding clinical implications, such one- to- one interventions are strongly recommended for children with Down Syndrome considering their behavioral characteristics. The schoolteachers might be worried that individual interventions take too much time to carry out in class. This suggests that creating a group format for these interventions might be more practical for teachers to use (Reilly, ٢٠١٢)

Limitations

This study has several limitations. First, graded programs are needed to apply the intervention to children with different intellectual levels from mild to severe mental retardation. Second, the study did not evaluate a wide variety of cognitive abilities. Children with DS have diverse cognitive profiles. The reading ability in children with DS is related to cognitive abilities including IQ, phonological awareness, and listening comprehension (Sermier Dessemontet, ٢٠١٥).

Furthermore, repeated measurements of these cognitive abilities may help to determine the cognitive function related to the improvement in letter knowledge. Children's behavior and emotions might influence the results of interventions. More interventions and assessments are needed to improve reading comprehension in children with DS.

Conclusion

The findings from this study underscore the importance of incorporating orthographic support into language learning programs for children with DS. The results indicate that these children are not inherently impaired in their phonological learning abilities but can benefit significantly from the presence of orthography. This dual-modality approach—combining visual and auditory learning—proves to be a highly effective strategy in enhancing word learning accuracy and retention.

Educational Implications

The study suggests that educators and therapists should integrate orthographic support into their teaching methods. By doing so, they can provide a more supportive learning environment that addresses the specific needs of children with DS. This approach can help bridge the receptive-expressive gap commonly observed in these children, thereby improving their overall language proficiency.

Future Research

While the study presents promising results, further research is needed to explore the long-term effects of orthographic support on language development in children with DS. Future studies could also investigate the impact of such interventions across different age groups and in diverse linguistic contexts to validate and expand upon these findings.

In summary, the integration of orthographic support into language learning frameworks holds considerable promise for enhancing the educational outcomes for children with DS, paving the way for more inclusive and effective teaching practices.

Also, the usability of Artificial intelligence for addressing the deficits of phonological skills and other skills in down syndrome community is very important to be investigated. The individuals with phonological impairment survive with limited communication skills, therefore, they hardly perform daily life assignments.

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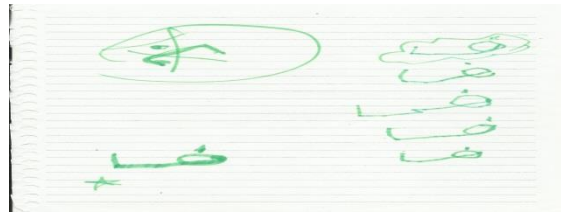
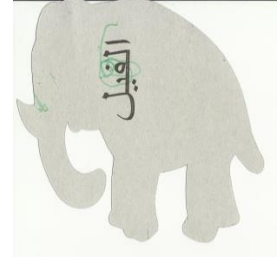
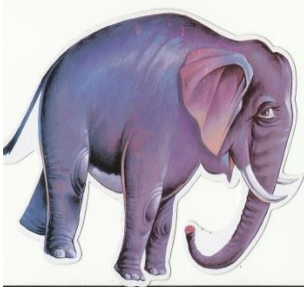
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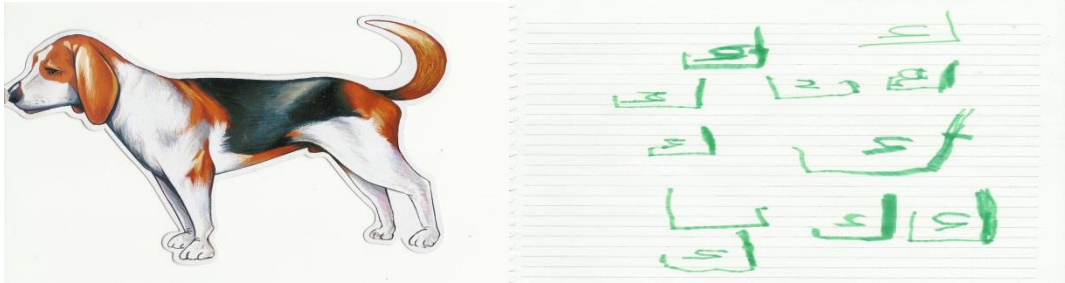
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Appendix I

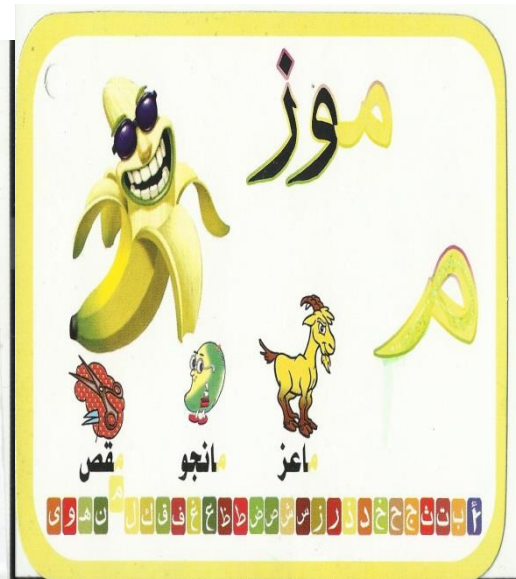
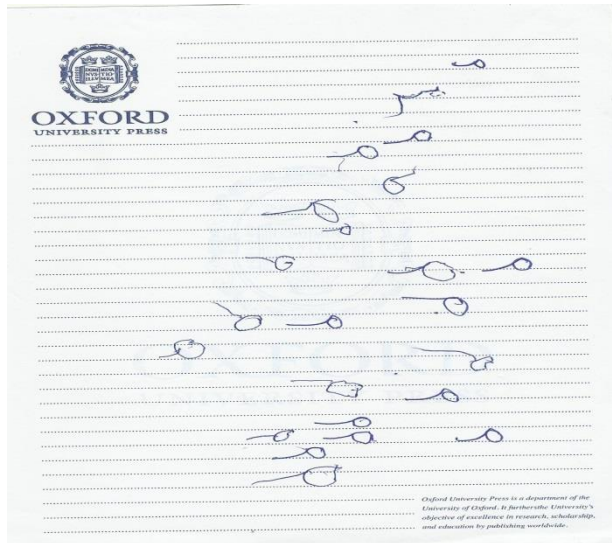
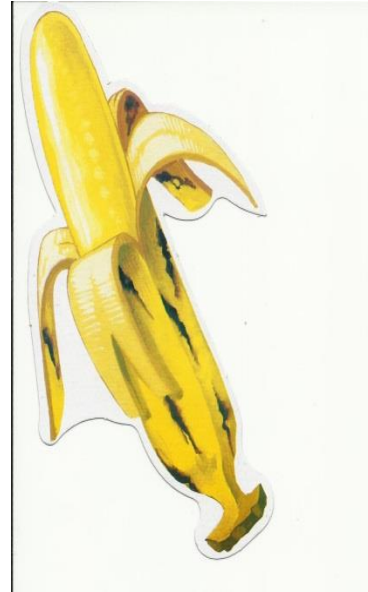
/b/ ب	/t/ ت	/g/ ج	/m/ م	/f/ ف	/k/ ك
/bortoa:n/ برتقال	/tamr / تمر	/gazar/ جزر	/mo:zə/ موز	/farawlə/ فراولة	/korsi:/ كرسي
/batti:xə/ بطيخ	/tuffah/ تفاح	/gæml/ جمل	/mænɤə/ مانجه	/fara:ʃə/ فراشة	/kælb/ كلب
/bmt/ بنت	/tɪmsæ: fi / تمساح	/gæwæ:fæ/ جوافة	/mæʃzæ/ معزه	/fostæ:n/ فستان	/ketæ:b/ كتاب
/batta/ بطة	/tæ:g/ تاج	/gara:r/ جرار	/maʔass/ مقص	/fi:l/ فيل	/kæmi:ra/ كاميرا

/f/ sound.

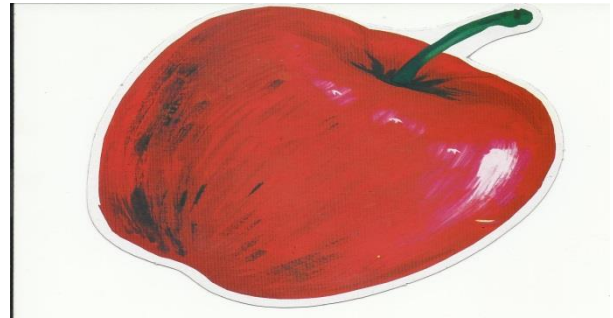
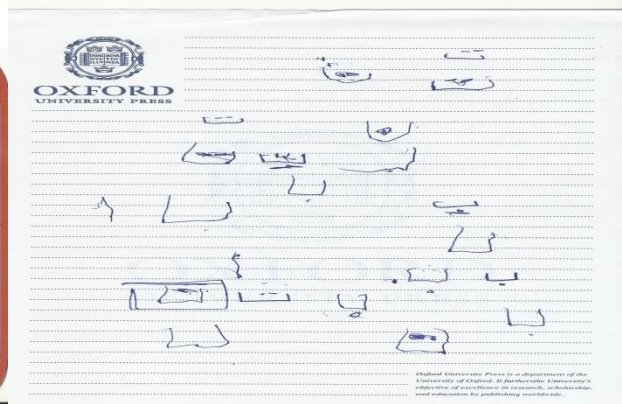
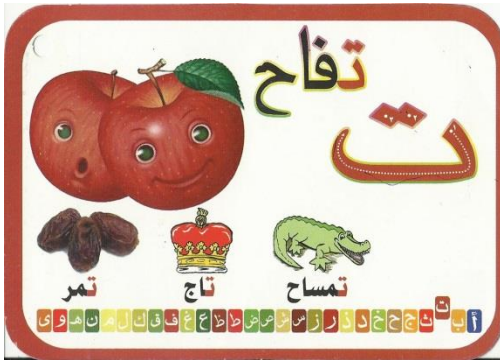
/k/ sound.



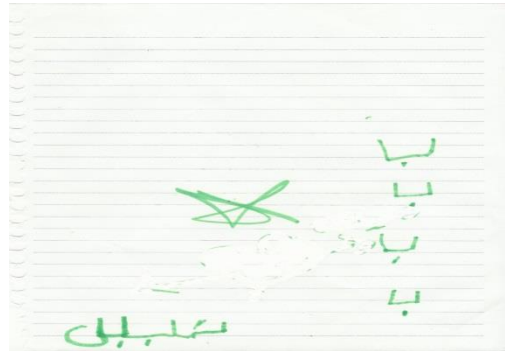
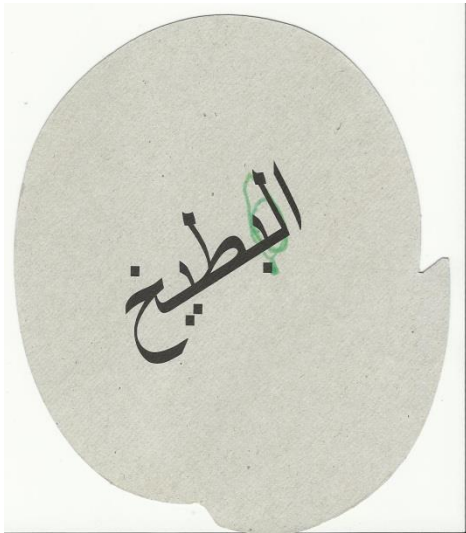
/m/ sound



/t/ sound



/b/ sound



/g/ sound

