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Writing Units or Decades First in Two Digit Numbers Dictation Task: The Case of Arabic an Inverted Language.

Betea

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?**Why Transcoding**

- An **important component of number processing** is the ability to transcode between the **oral and written** counting systems.

- It is the ability to **write** a numeral to correspond to a spoken number word, or **read** an Arabic numeral aloud.

- For example, 4 corresponds to

- 'vier' in German

- 'quatre' in French

- ''ארבע' (arba) in Hebrew,

- أربعه' (arba'ah) in Arabic,

- and 'four' in English.

?Why Two-digit Numbers

- **Syntactic Structure (cross-linguistic):**
- Units-Decades
- Decades-Units
- **Differential syntactic structure Transparency according to number category:**
- Numbers **10-20 (mostly teen numbers)**, e.g. 15 Fifteen.
- **Whole-tens** or **decade number**, e.g. 60 Sixty
- **Other two-digit numbers**, e.g. 23 Twenty-Three.

Why in Arabic?

- There is some evidence that transcoding, and related skills such as written number comparison, are easier in languages with **transparent oral counting systems.**

- These make the relationship between tens and units explicit (e.g. the equivalent of 'ten-one' instead of 'eleven'; 'two-tens' instead of 'twenty'; 'two-tens-one' instead of 'twenty-one').

- Such languages include Chinese and other East Asian languages (Miura et al, 2003) and Welsh (Dowker, Bala & Lloyd, 2008).

Why in Arabic? Inversion

- Studies of speakers of European languages have shown that children's and adults' transcoding and two-digit number comparison may be more difficult if their counting system has the **inversion feature** (Moeller et al, 2009; Nuerk, Weber & Willmes, 2005; Zuber et al, 2009).

- This means that the **units precede the tens** in the oral counting system (e.g. 'three and twenty' for 23).

- Examples of languages with the inversion feature for counting include German, Dutch and Danish.

Why in Arabic? Inversion

- The Arabic written counting system is unusual in using Hindi rather than 'Arabic' numerals.

- Numbers in Arabic are written as (٠١٢٣٤٥٦٧٨٩), rather than the commoner format of (0123456789).

- However, both systems use base ten, and identical ways of representing place value.

- **In Arabic, as in German and a few other languages, the oral counting system has the inversion feature (24 = four and twenty).**

Arabic Number System

- The word numbers for 13 to 19 can be derived from the one-digit word numbers, whereas the word numbers for 11 and 12 are not consistent, e.g. ‏أحد عشر (حداش\حدعش)‏"11and"‏إثنا عشر (تناش\تناعش)‏"-12- but "واحد"-1 ."إثنين (تنين\ثنين)‏"-2.

- Moreover, the order of unit and decade word numbers in two-digit numbers is reversed in Arabic; for example, 18 is called "eight-ten" ‏("ثمانية عشر\ثمنتاش\ثمنتعش")‏ and 27 is called ‏"سبعة وعشرين".‏

- After learning the teens (11-19), Arabic-speaking children should also memorize the names of whole tens (20, 30, 40...) that are identical or similar to one-digit word numbers adding the suffixes " ‏ون \ ين‏ " at the end (‏ستون = ستة+ون \ستين = ستة+ين=60 ,‏سته=6).

Why in Arabic?
Reading/writing & Math Direction

- Arabic, like Hebrew and Persian, is written from **right to left** (ضياء ابراهيم غنايم←) while **numbers** are written from **left to right** (➔ 5+6=11).

- Thus, in **Arabic,** the order of units and decades in the oral counting system does **NOT** correspond with the order of units and decades in the written counting system but **DOES** correspond with the direction of reading and writing of words.

- In **English** and most other European languages, the order of units and decades in the oral counting system corresponds both with the order of units in the written counting system and the direction of reading and writing of words.

- In **Hebrew**, the order of units and decades in the oral counting system **DOES** correspond with the order of units and decades in the written counting system but does **NOT** correspond with the direction of reading and writing of words.

- In **German**, Dutch and Danish, the order of units and decades in the oral counting system corresponds **NEITHER** with the order of units in the written counting system **NOR** with the direction of reading and writing of words.

The current study

- Examines how the **transparency** and **inversion** features of word numbers influence the **pattern of two-digit numbers writing** especially the **writing order of units and decades** in **transcoding to dictation** task across **lifespan**.

Method- Participants

- 77 pupils (56 male, 21 female) from primary school

- 66 pupils (52 male, 14 female) from junior high school

- 72 pupils (45 male, 27 female) from high school

- 72 students (38 male, 34 female) from higher education.

- All participants lived in Arab-majority areas of Israel and spoke Arabic as their first language (L1).

Method- Task

- The transcoding tasks consisted of the writing of 32 two-digit numbers pre-recorded by the experimenter.

- The numbers ranged from 10 to 100 and included 8 numbers from four two-digit numbers categories:

- (1) Teen numbers 12-13-14-15-16-17-18-19

- (2) Identical unit-decade numbers 22-33-44-55-66-77-88-99

- (3) Whole-tens numbers-20-30-40-50-60-70-80-90

- (4) Other two-digit numbers.

- The order in which numbers were presented was random for each participant.

Possible writing patterns to dictation

Number Category	Example	Syntactic Structure	Writing Decades First Number (Left-Right) Nonstandard Text (Right-Left)	Writing Units First Nonstandard Number (Left-Right) Text (Right-Left)
Teens	13 – ثلاثة عشر	Units-Decades	Working Memory	Short Term Memory
Whole Tens	40- اربعون	Decade-Suffix	Short Term Memory	Working Memory
Identical	55- خمسة وخمسون	Units-Decades	Working Memory	Short Term Memory
Other 2-digit	38 – ثمانية وثلاثون	Units-Decades	Working Memory	Short Term Memory

Results-Decades First Writing Pattern

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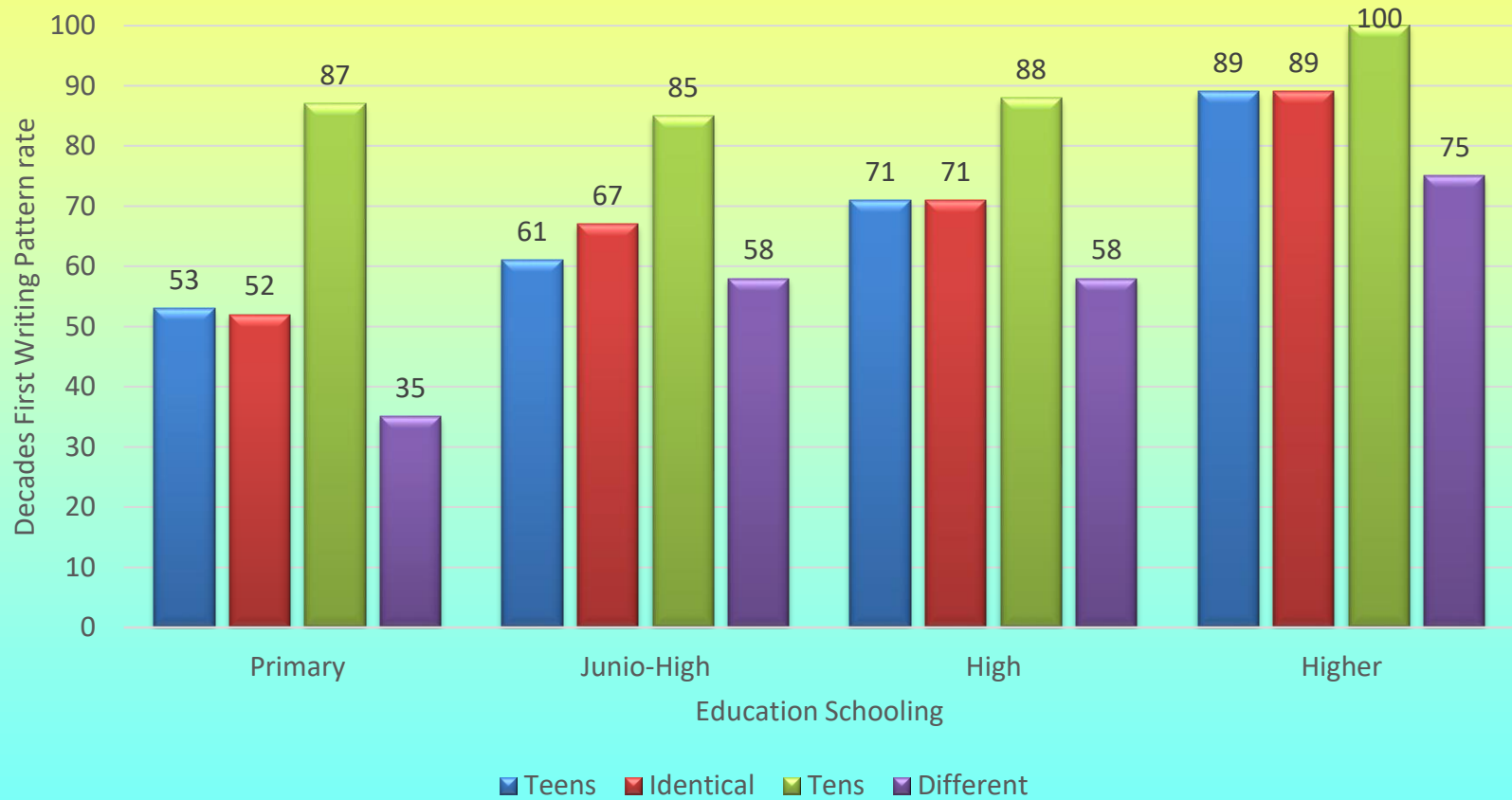
Results

- In general, Arabic speakers adopt the decades first writing for transcoding of two-digit numbers. This strategy was used for 78% of items, and the units-first strategy for only 22% of items.

- An interaction was observed between the educational schooling -primary, junior high, high and higher education and the number categories – teen numbers, identical decade-unit numbers, whole-tens numbers, and other two-digit numbers.

- The syntactic structure of the numerical system (order of units and decades) of the Arabic language, affects the transcoding process in the two-digit number writing from dictation task differentially, especially with regard to whole-tens numbers (decades first- ستون = ستين \ ستين = ين+ستة=ستة+ون = ستون, 60 ,سته=6) and other two-digit numbers (units first- 40+6 = ستة واربعون).

Results

- Since whole-tens are dictated with decades first, even primary school pupils adopt the decades-first writing pattern (Left to Right) as is used for number writing but opposite to text writing (Right to Left) in Arabic.

- For the other-two-digit number category, primary school pupils adopt the units-first writing pattern (Right to Left) as is used for text writing in Arabic but is the opposite direction to the standard number-writing direction. This may place less of a load on working memory.

- Junior-high, high school pupils and even higher education students used the units-first writing pattern more often for the other-two-digit-number category than for the other categories.

<u>Discussion</u>

- In general Arabic speakers adopt the decade-first writing pattern for two-digit numbers especially when it is consistent with their syntactic structure as in whole- tens.

- This first decade writing pattern becomes increasingly evident in junior-high school, high school and higher education, as proficiency improves in math and in second and third languages.

- However, this pattern is modulated by the complexity of the decade- unit structure and the working memory capacity that is required to deal with it.

- This complexity is most pronounced in numbers where it is important to keep the numerical syntactic structure in mind (the other-two-digit-number category) than where the syntactic structure in instantly transparent (especially the whole-tens category). Additionally, there are effects of the consistency or inconsistency between the reading direction of text (Right to Left), the two-digit number reading direction (Right to Left) in Arabic and the taught number writing direction taught (Left to Right), which influence the load placed on working memory.

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Thank you !

- Any Questions ?

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