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# Narrow and broad functions of negation in a miniature artificial language

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## Background

- ❖ Negated words and statements result in higher processing difficulty when compared to non-negated statements. This processing cost can show up in the form of higher error rates, longer response times, longer fixation durations or a higher number of regressions.
- ❖ Some studies suggest that the processing cost associated with negation is not only restricted to syntactically negated information but words with negative semantics such as *few*, *a small proportion* and *forget* also take longer to process than affirmatives (Clark, 1969; Just & Carpenter, 1971; Just & Clark, 1973). If this is in fact true, prefixally-negated words such as *unhappy* – called the “narrow” function of negation in this study – should also involve a processing cost compared to their non-negated counter-part such as *happy*. How does this type of negation compare with a more common negation type in which *not* operates on a scalar adjective (*not happy*) – called the “broad” function of negation in this study – and can result in a wider range of interpretations?
- ❖ Previous studies that have compared these negation types to non-negated expressions have not found conclusive results. While in one study, it was found that prefixally-negated expressions lead to a higher processing difficulty compared to non-negated expressions (Sherman, 1973), two other studies did not find any difference between a non-negated form and a prefixally-negated form (Sherman, 1976; Hoosain, 1973). However, all three studies found a higher processing cost for the broad negation type (*not happy*) compared to the narrow negation type (*unhappy*). Whether prefixally-negated words function more as single lexical items rather than negated items is still debated.
- ❖ Two potential confounds in all these studies are 1. Length differences and 2. Frequency differences between the negated forms and the non-negated form listed below:

Narrow negation: *unhappy*  
Broad negation: *not happy*  
No negation: *happy*

## Research goals

### What?

- ❖ Test the processing cost associated with the narrow negation (*unhappy*), broad negation (*not happy*) and no-negation form (*happy*)?

### How?

- ❖ Investigate any differences in response times and error rates as well as error types in the negated and non-negated conditions?
- ❖ Control for length and frequency differences between the forms by using artificial language learning (ALL) to reach more convincing results.

## Design and materials

- ❖ **Participants:** 28 Swedish native speakers (15 females, mean age of 24.5)
- ❖ **Artificial language learning (ALL):** Negation types represented through three artificial prefixes:
  - *ka*: narrow negation
  - *va*: broad negation
  - *sa*: no negation; empty prefix with no meaning
- ❖ **Stimuli:** Artificial adjectives with scalar meanings used as negated concepts for the task:

Table 1. Adjectival meaning dimensions and their corresponding artificial words

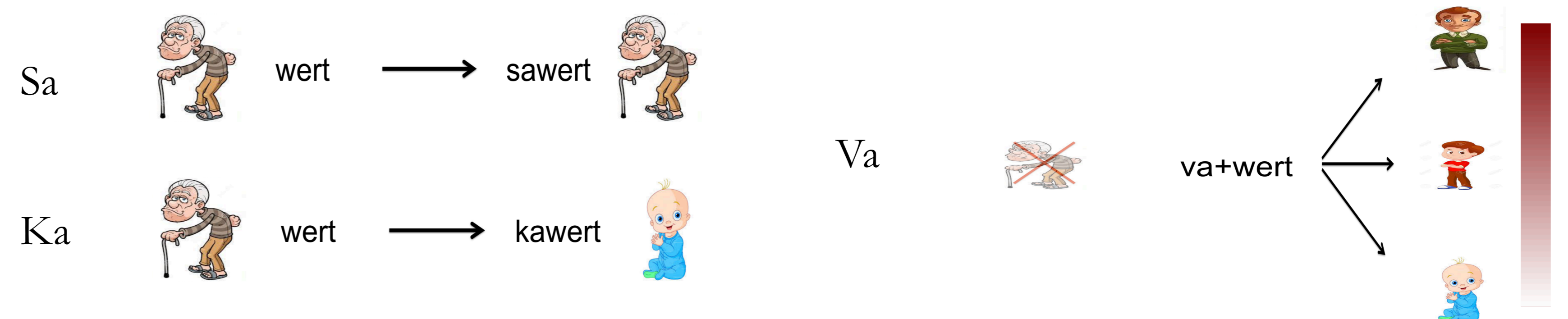
| Learning phase |                 | Testing phase     |                 |
|----------------|-----------------|-------------------|-----------------|
| Adjective pair | Artificial word | Adjective pair    | Artificial word |
| OLD-YOUNG      | wert            | FULL-EMPTY        | reft            |
| WHOLE-BROKEN   | misk            | FAT-THIN          | kemp            |
| CLEAN-DIRTY    | flin            | HOT-COLD          | visk            |
| RICH-POOR      | murd            | LARGE-SMALL       | lemp            |
| HAPPY-UNHAPPY  | prab            | TALL-SHORT        | blot            |
|                |                 | CROWDED-UNCROWDED | bran            |
|                |                 | TIGHT-LOOSE       | relk            |
|                |                 | STRONG-WEAK       | sard            |

## Experimental considerations

- ❖ Each artificial word used for the testing phase (Table 1) was assigned to one end of the scale (FULL) for half of the participants and was assigned to the other end of the scale (EMPTY) for the other half.
- ❖ In the testing phase, new images corresponding to the learned concepts were used.
- ❖ The testing phase started with 27 practice trials using the adjectives from the learning phase.
- ❖ Each trial in the testing phase was followed by a feedback component in which participants learned whether their response was correct or incorrect.
- ❖ The images used in the testing phase always consisted of three states of the same scalar dimension in an ascending order in half of the trials and in a descending order in the other half.

## Procedure

- ❖ **Learning phase [part 1]:** 5 artificial pairs (Table 1) used for teaching the three prefixes learned through images:



- ❖ **Learning phase [part 2]:** 8 novel artificial adjectives for the testing phase, learned through images:



- ❖ **Testing phase:** combination of prefixes and novel adjectives tested through a picture-word matching task (a total of 72 trials):

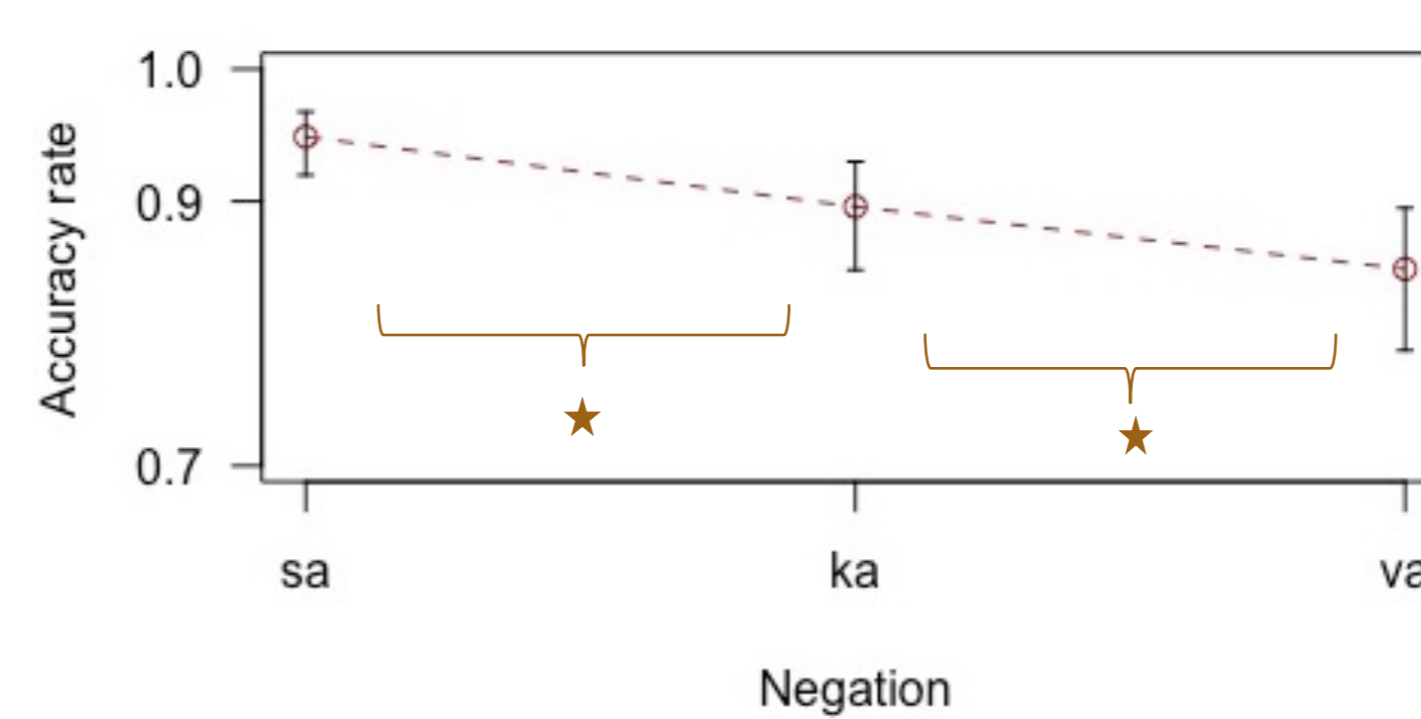
|        | Condition 1 | Condition 2 | Condition 3 |
|--------|-------------|-------------|-------------|
| sareft | True        | False       | False       |
| vareft | False       | True        | True        |
| kareft | False       | False       | True        |



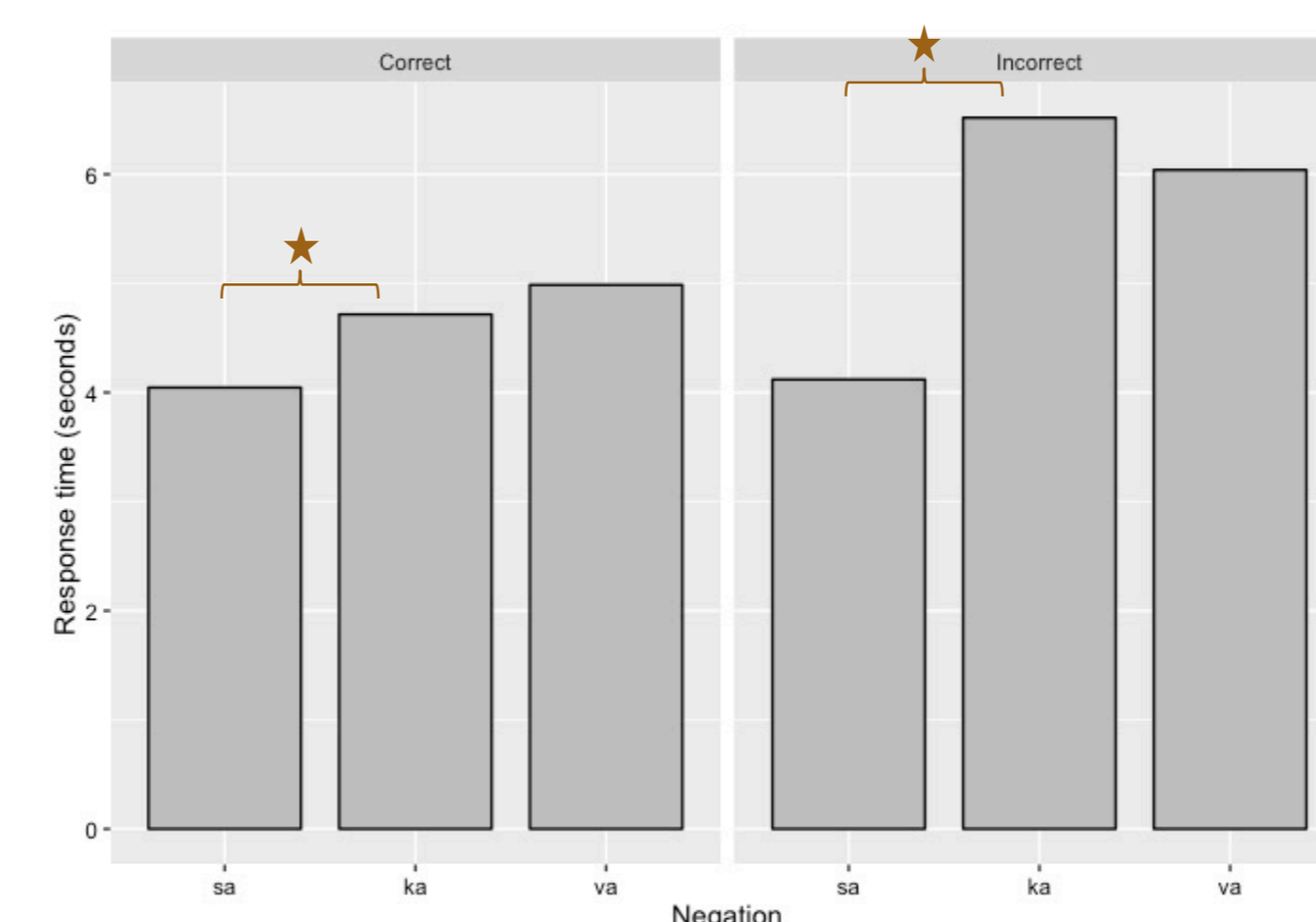
## Analysis and results

- ❖ Linear mixed effects and mixed effects logistic regression models were used for analysis.
- ❖ Errors were divided into False Alarms (FA) and Misses (M) for further analysis.

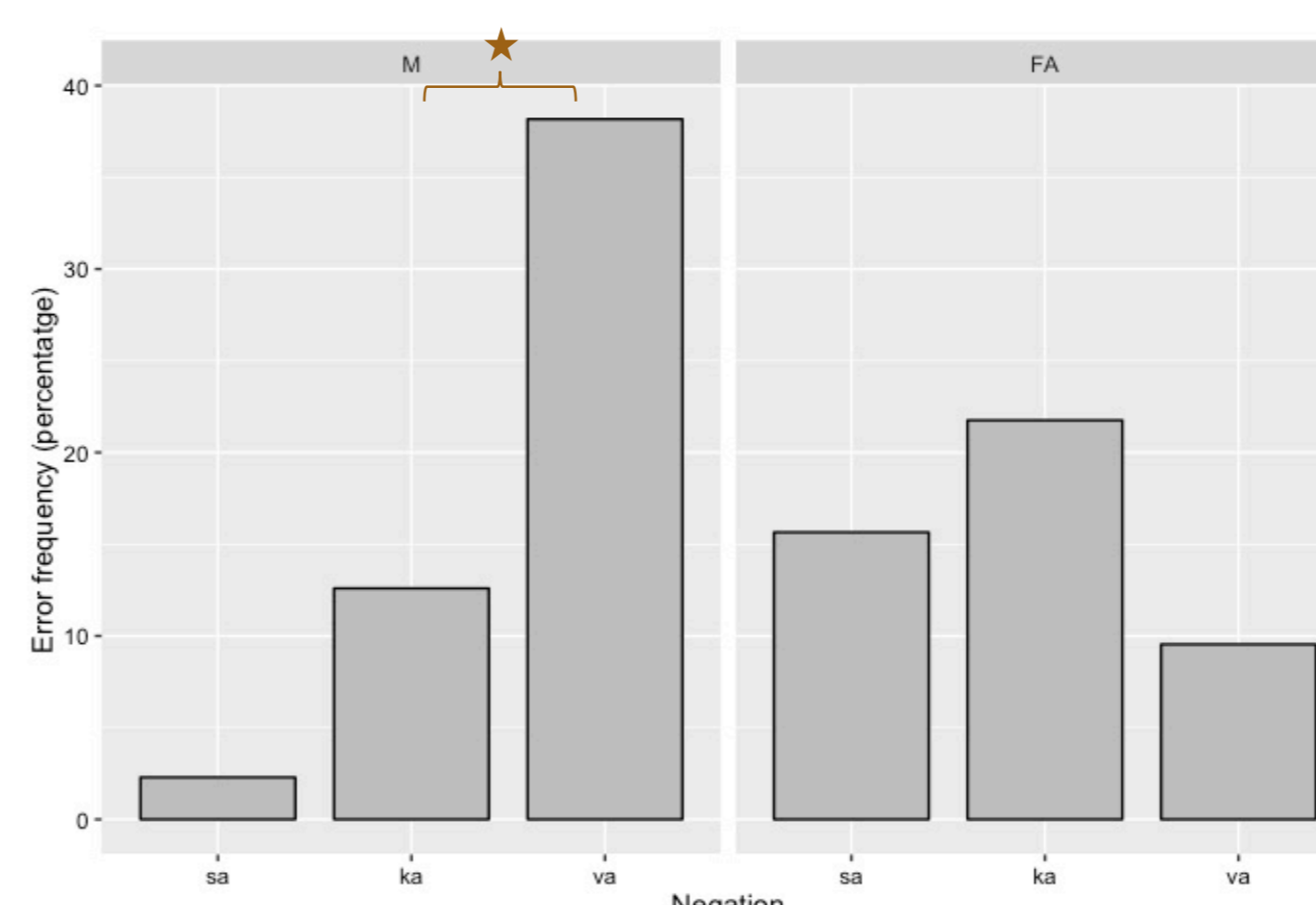
### 1. Average accuracy rate for the three conditions



### 2. Average response time for the three conditions in correct and incorrect responses



### 3. Frequency of error types in the three conditions



## Discussion

- ❖ A higher accuracy rate was observed for the no-negation condition, narrow condition and broad condition, in that order. This suggests a higher processing difficulty for narrow negation (*unhappy*) compared to the base form (*happy*), but that this processing difficulty is not as high as the broad negation (*not happy*).
- ❖ Significantly longer response times were found for the two negation conditions compared to the no-negation condition, in both correct and incorrect responses. This suggests that both negation types were significantly more difficult than the no-negation condition.
- ❖ No differences were found in the response times between narrow and broad negation types, suggesting they were both equally difficult in this ALL task.
- ❖ The error analysis revealed that the highest proportion of errors was of the Miss type and these were made in the broad negation condition. This suggests participants had difficulty comprehending the function of broad negation, while this error type was not as common for the narrow negation. Participants found it easier to comprehend the function of narrow negation and less frequently missed the correct cases.

## Conclusions

- ❖ Further evidence in support of the difficulty of processing with negation
- ❖ Processing difficulty found for narrow negation (prefixal negation) compared to the no negation condition (base form), contrary to the findings in previous studies

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