



# Towards Icon Language Models

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What is AAC? Augmentative and Alternative Communication  
[https://www.youtube.com/watch?v=r3m8\\_YmTDDM](https://www.youtube.com/watch?v=r3m8_YmTDDM)

# Motivation for using Icons

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1. Require less selections than letters

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2. Do not require literacy

# Motivation for using Icons

1. Require less selections than letters
2. Do not require literacy
3. Can be more intuitive than words

# Motivation for using Icons\*

1. Require less selections than letters
2. Do not require literacy
3. Can be more intuitive than words

\*given optimal conditions

What are Optimal Conditions  
then?

Specifically from an NLP and a BCI  
point of view



# Building Blocks

Icon set

Selection Modality

Structure

# Building Blocks

Icon set

Selection Modality

Structure

Recent research

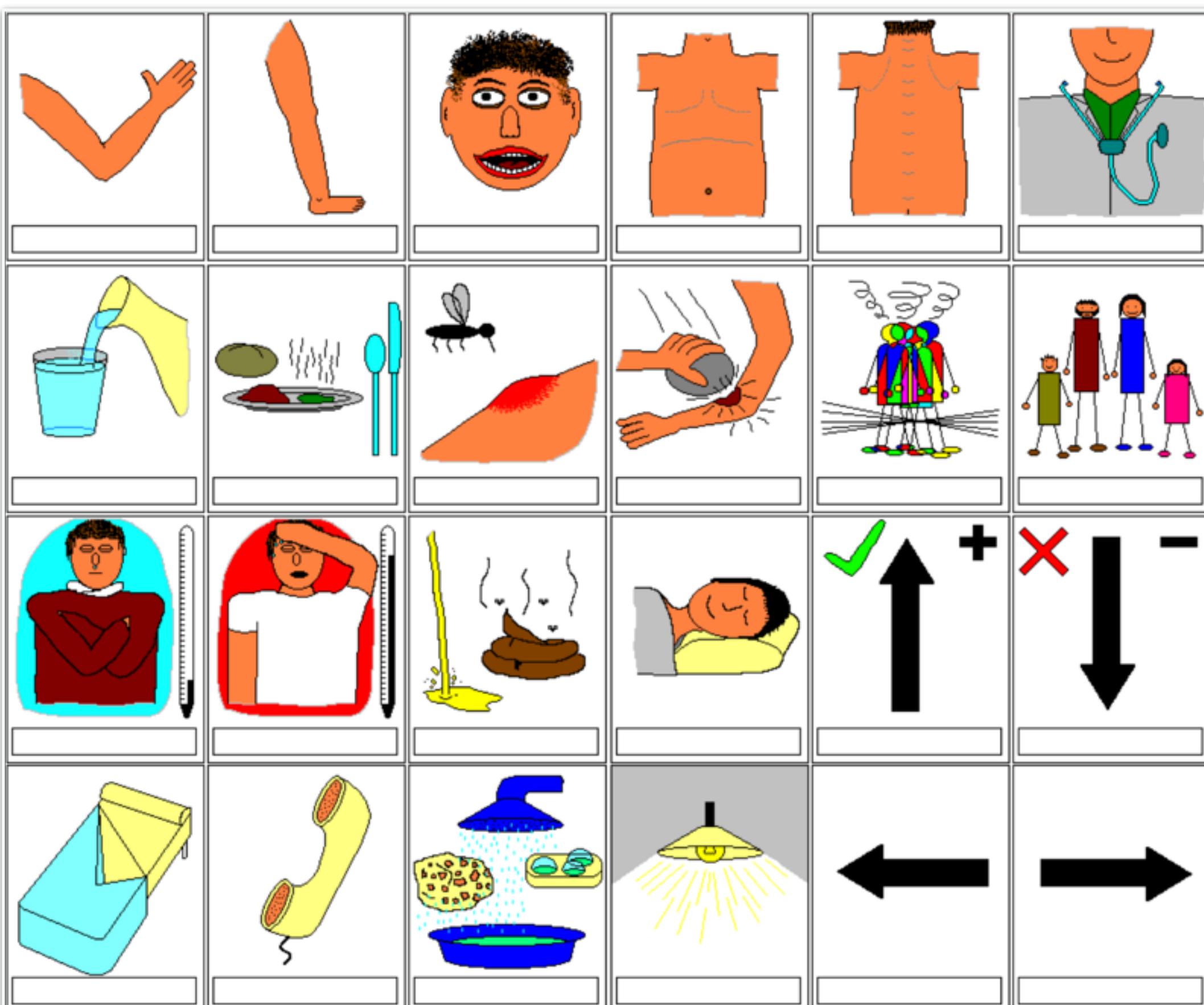
# Icon sets - examples

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## Picture Communication Symbol set

12,000 symbols that contain country specific libraries of icons as well

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34,000 symbols and is incorporated in news2you that provides an icon newscast for adult

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## Picture Communication Symbol set

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## SymbolStix icon set

34,000 symbols and is incorporated in news2you that provides newscast adult of icons FIX



# Icon sets - considerations

Content:

# Icon sets - considerations

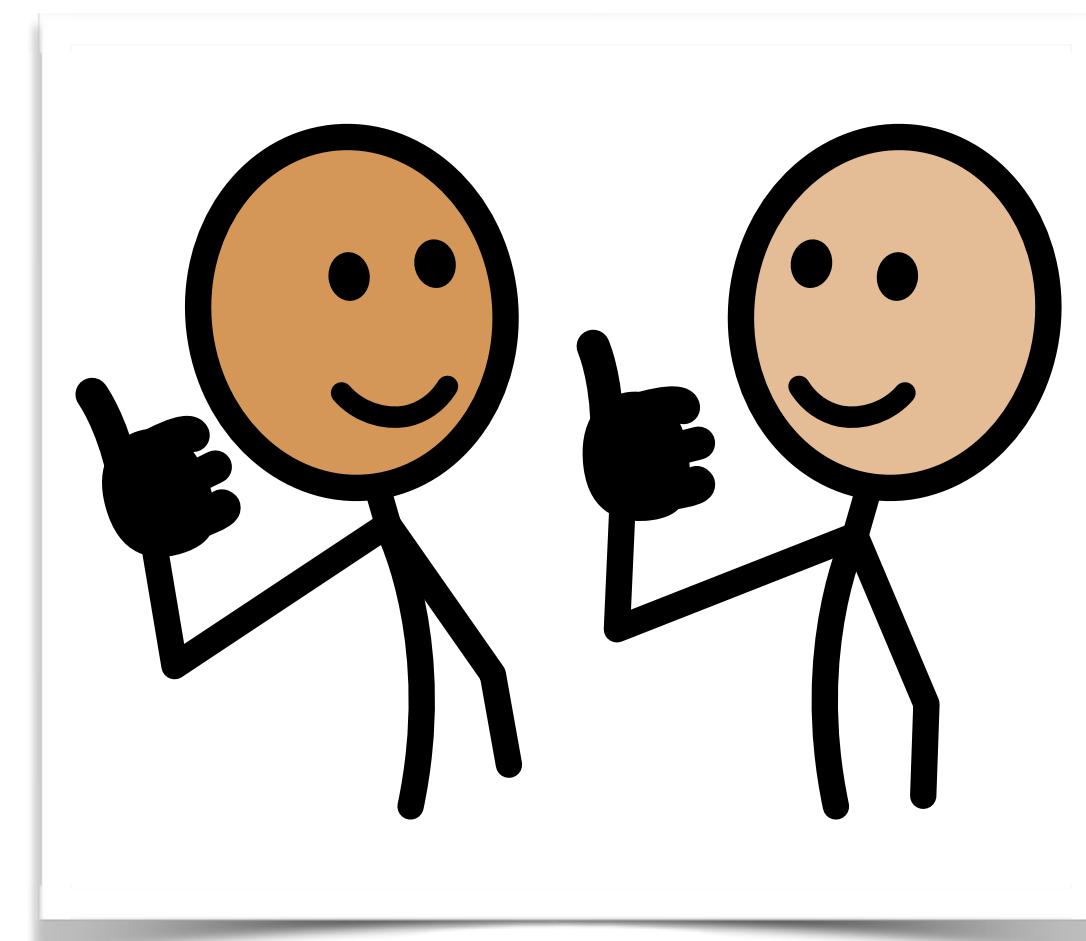
## Content:

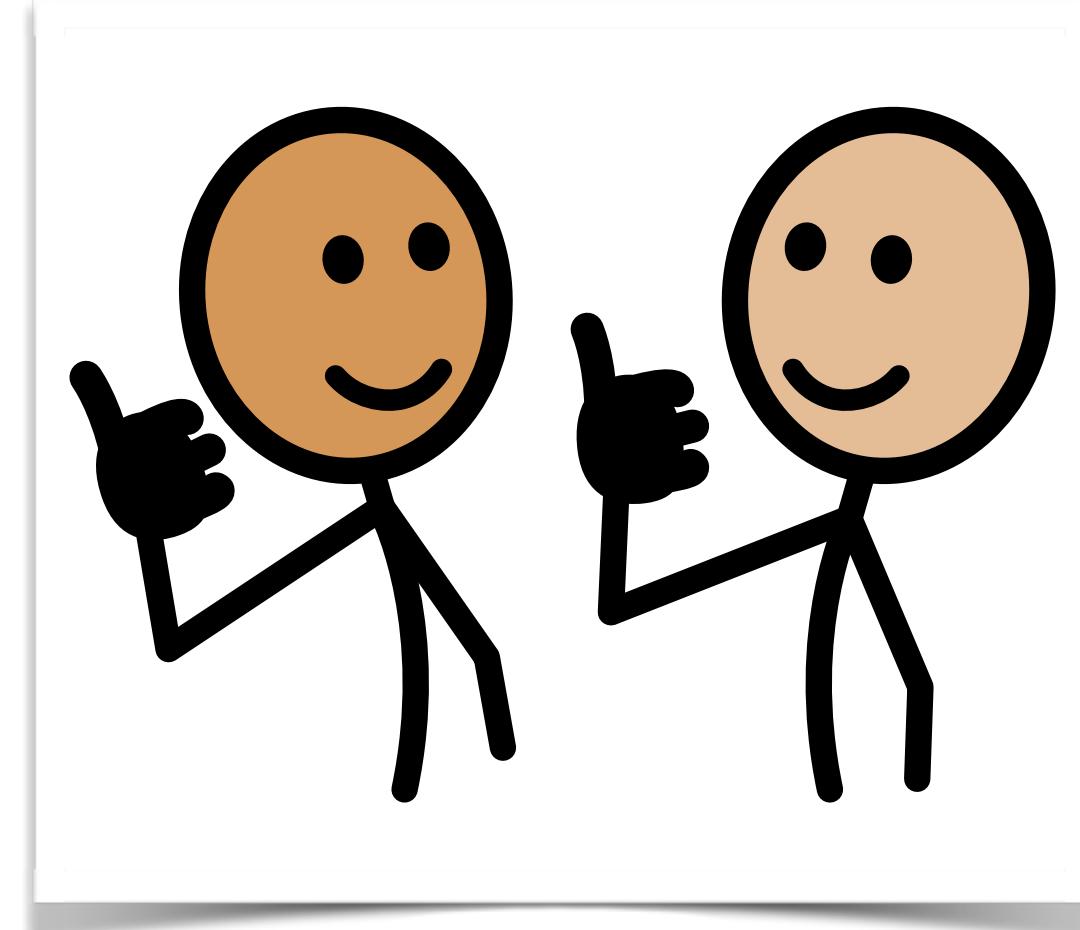
- Have sufficient coverage of the target population (children, adults)

# Icon sets - considerations

## Content:

- Have sufficient coverage of the target population (children, adults)
- Icon meta-data properties





name: agree

word type: verb

synonyms: agreement

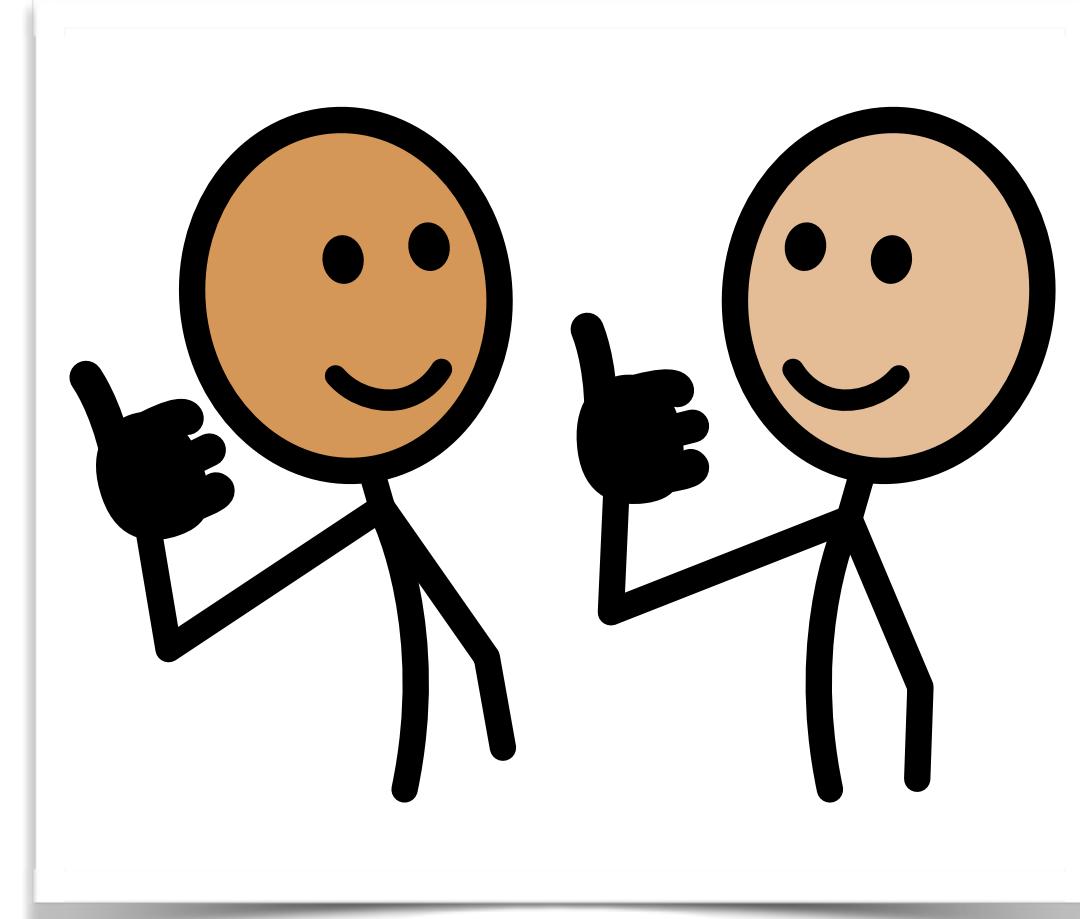
agreed      agrees

agreeing      approve

flexibility      concur

on the same page

see eye to eye



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word type: verb

synonyms: agreement

agreed      agrees

agreeing      approve

flexibility      concur

on the same page

see eye to eye





name: afraid

word type: adjective

synonyms:

eerie      frightened

fear      halloween

feared      nervous

fearful      scared

fears      scary

upset      terrified



name: afraid

word type: adjective

synonyms:

eerie      frightened

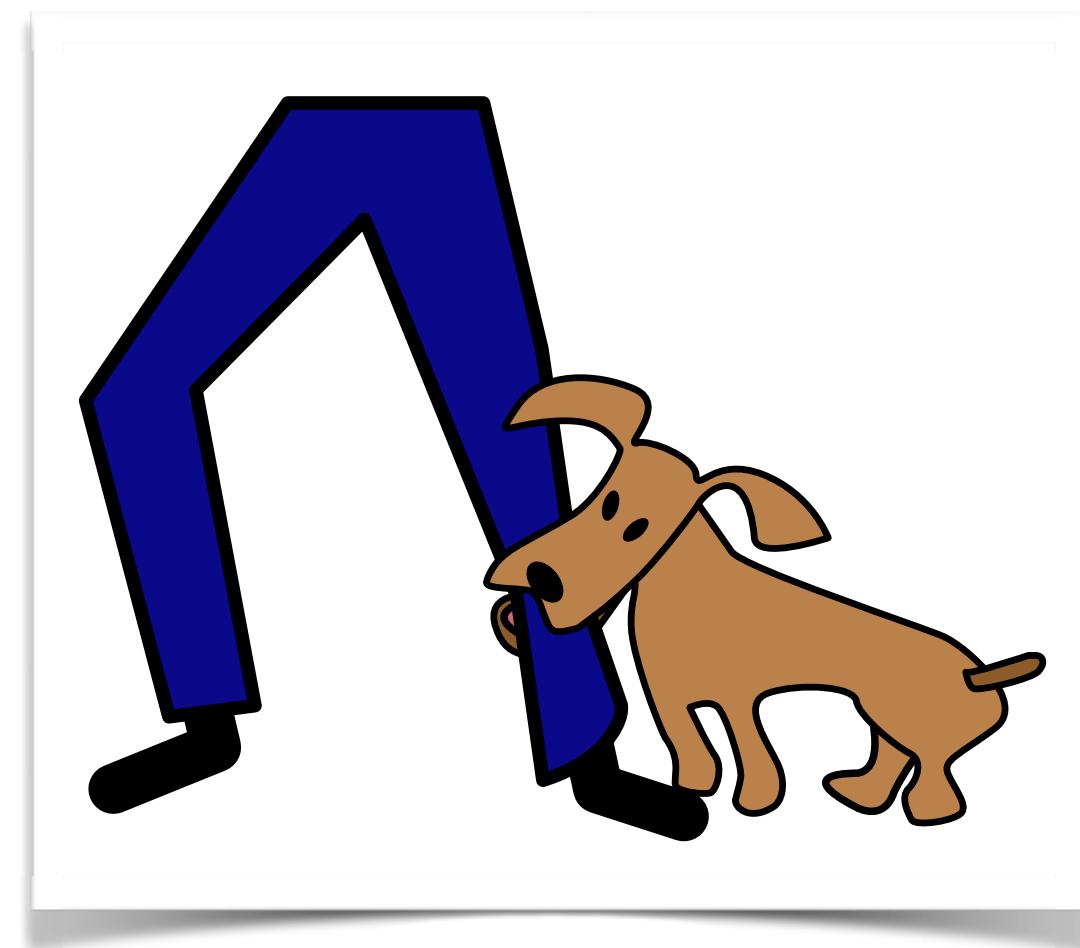
fear      halloween

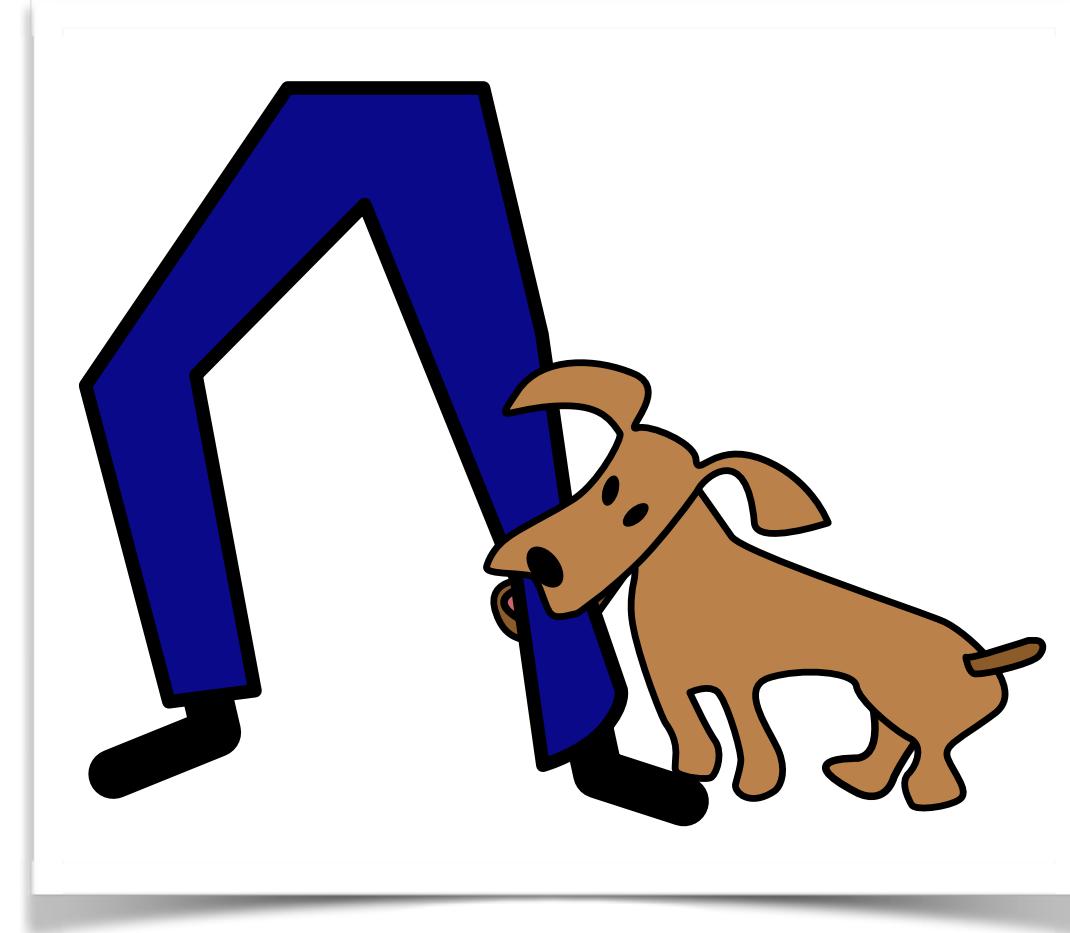
feared      nervous

fearful      scared

fears      scary

upset      terrified



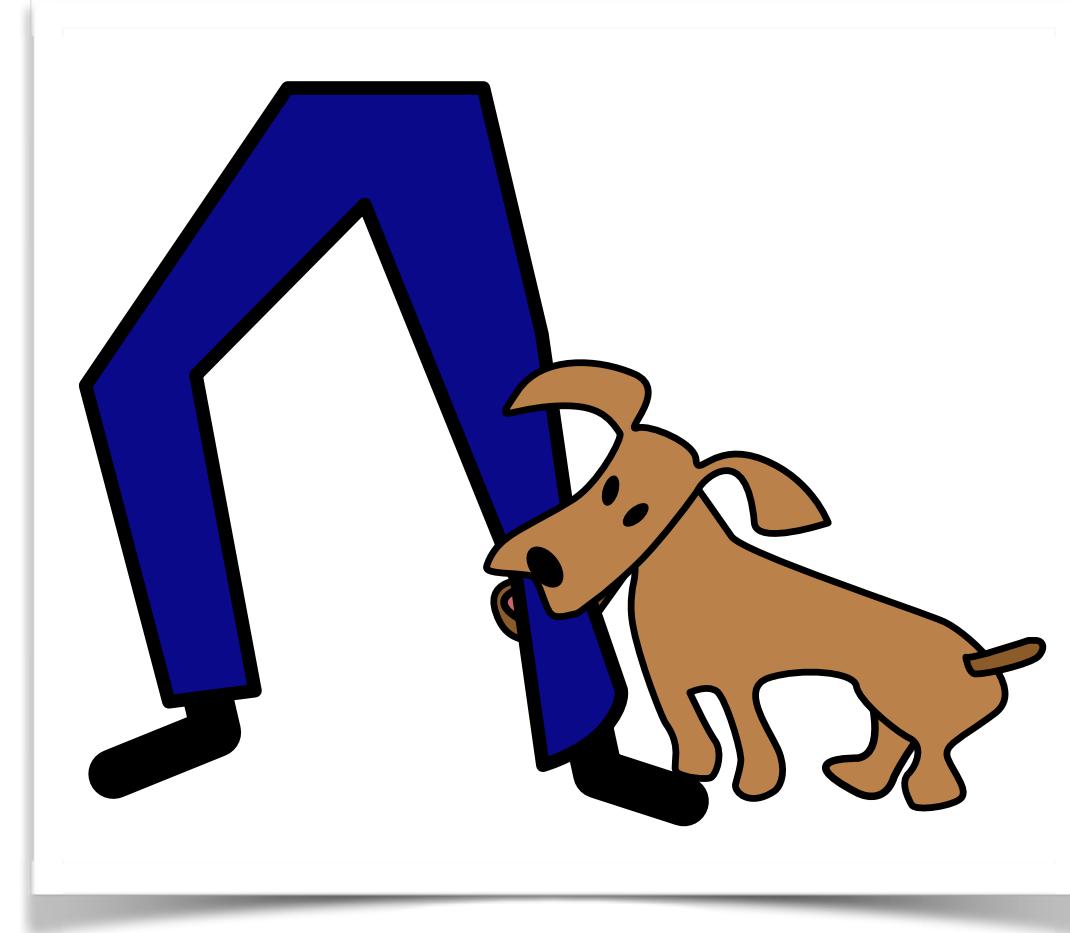


name: bite leg

word type: verb

synonyms:

bad day    dog bite



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synonyms:

bad day   dog bite

# Icon sets - considerations

## Content:

- Have sufficient coverage of the target population (children, adults)
- Icon meta-data properties

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- Have sufficient coverage of the target population (children, adults)
- Icon meta-data properties; specificity - interpretability tradeoff

# Icon sets - considerations

Visualization and Cognitive load:

# Icon sets - considerations

## Visualization and Cognitive load:

McDougall et al. described three main characteristics

# Icon sets - considerations

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1. concreteness

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1. concreteness
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3. distinctiveness

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# Icon sets - considerations

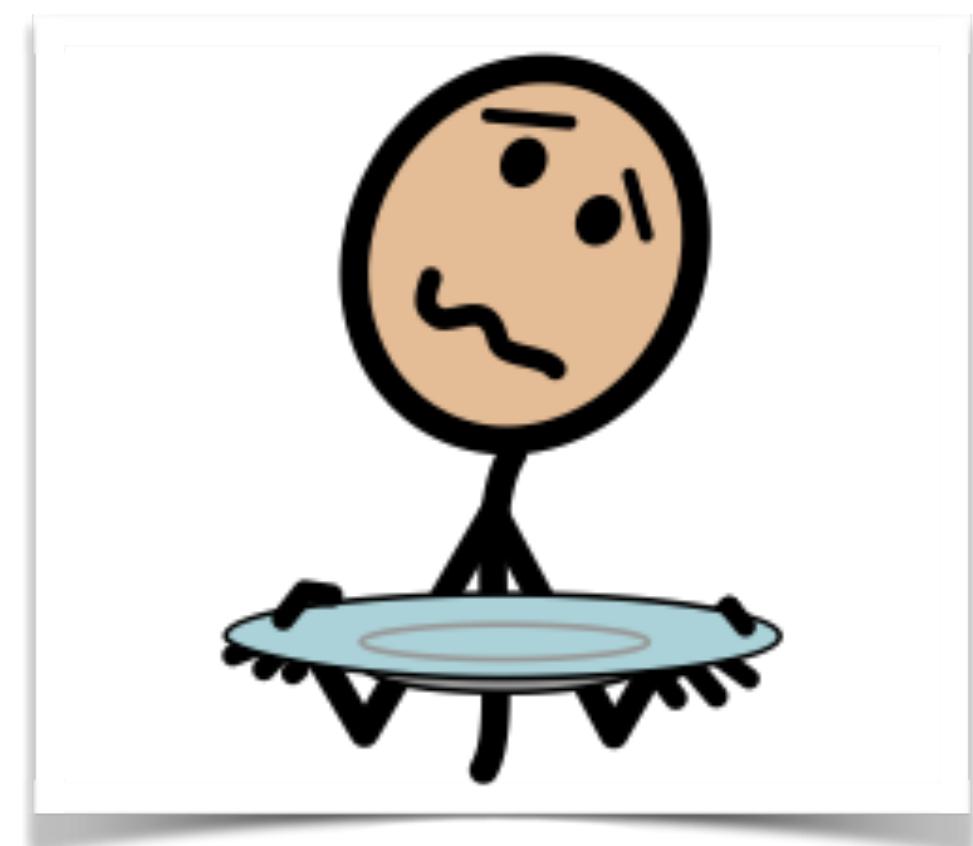
## Visualization and Cognitive load:

McDougall et al. described three main characteristics

1. concreteness - visual metaphor

# concreteness

# concreteness



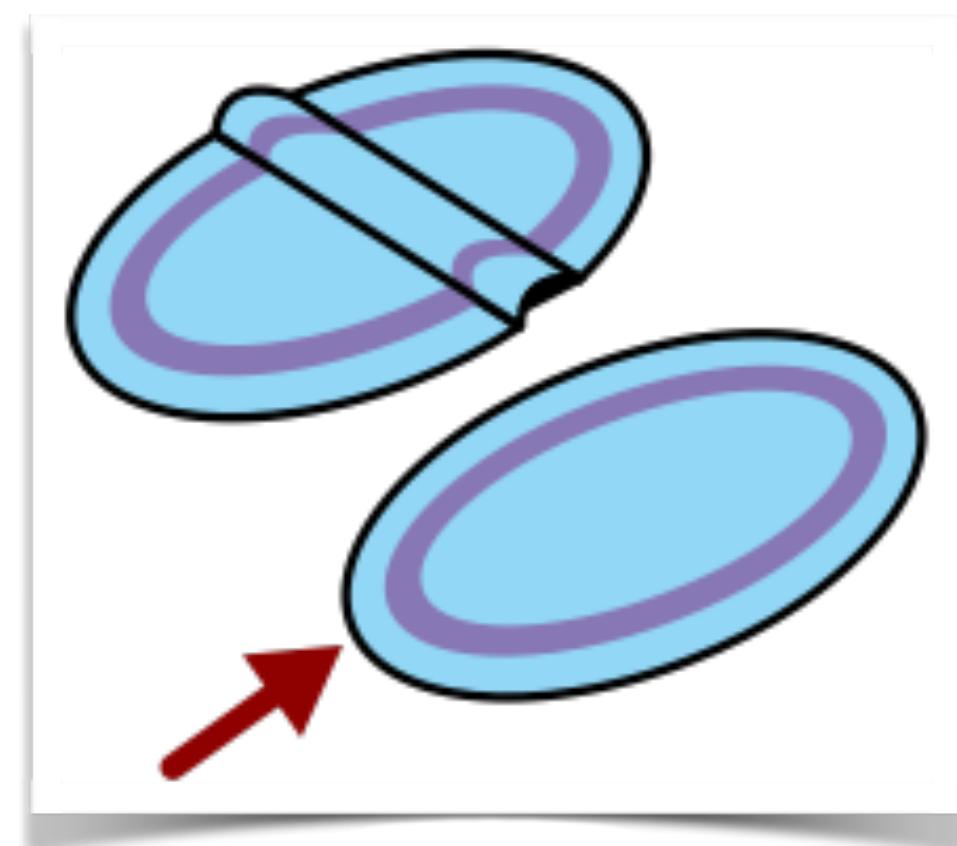
# concreteness



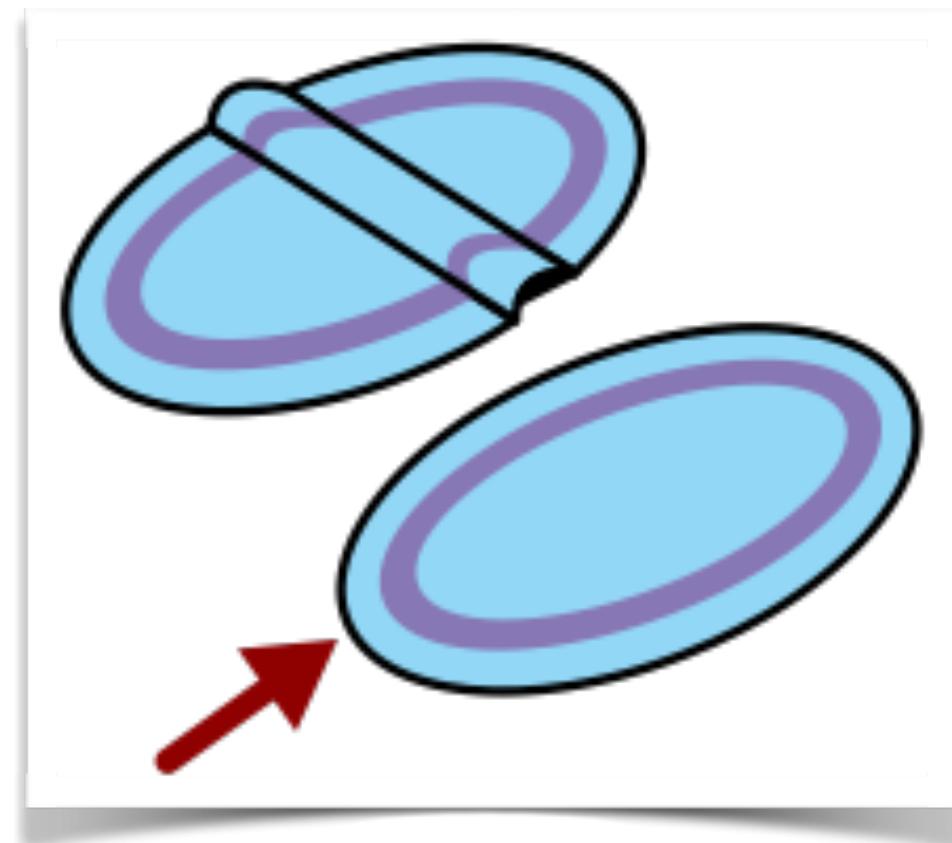
hungry

# concreteness

# concreteness



# concreteness



flat

# concreteness

# concreteness



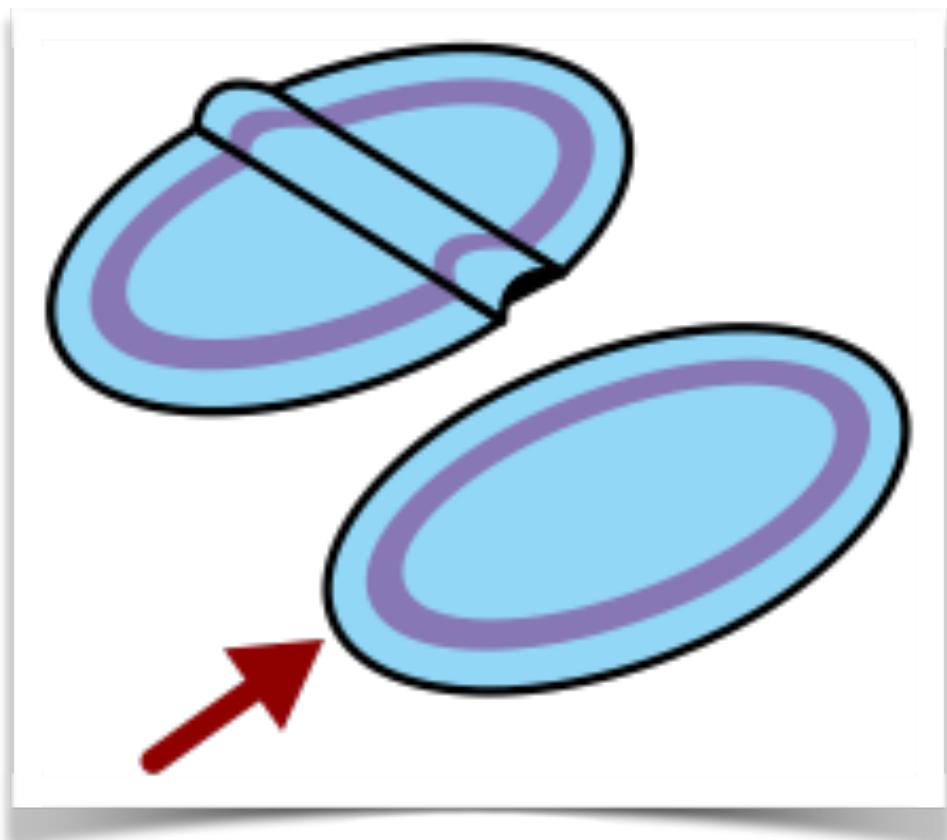
# concreteness



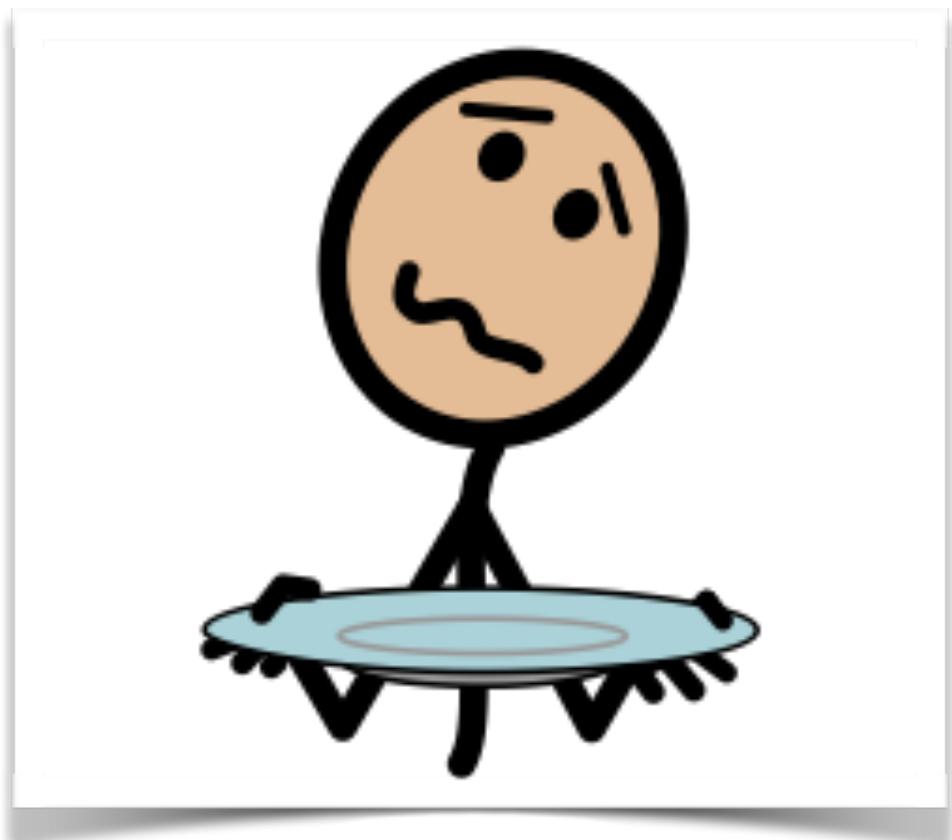
pom poms

# concreteness

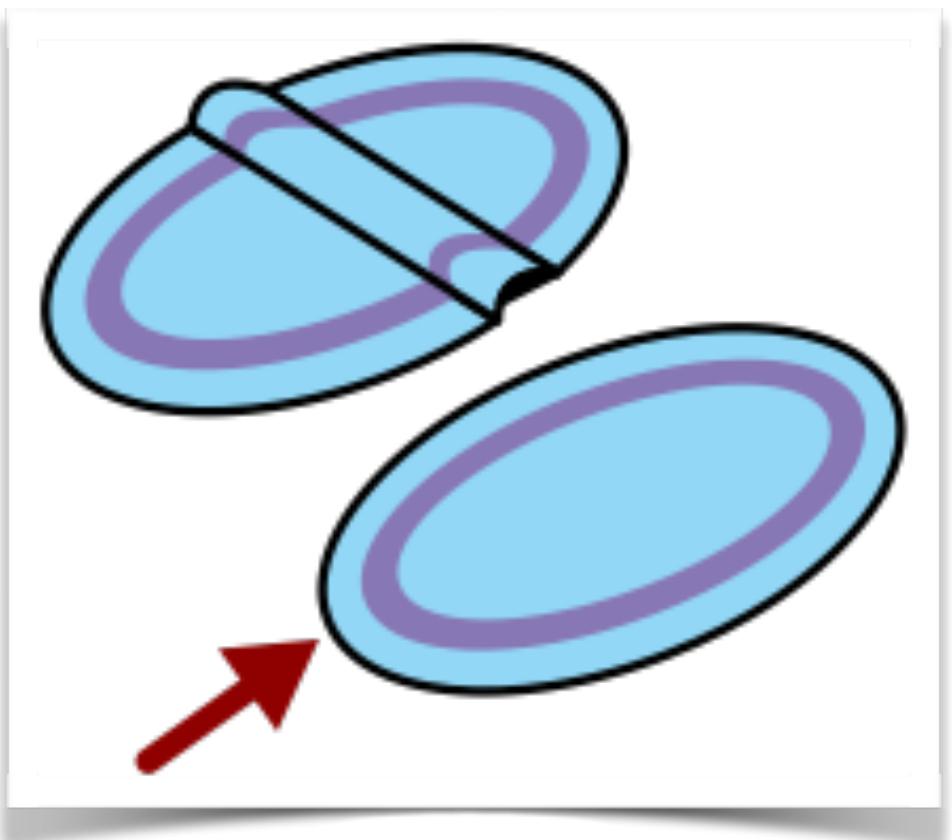
# concreteness



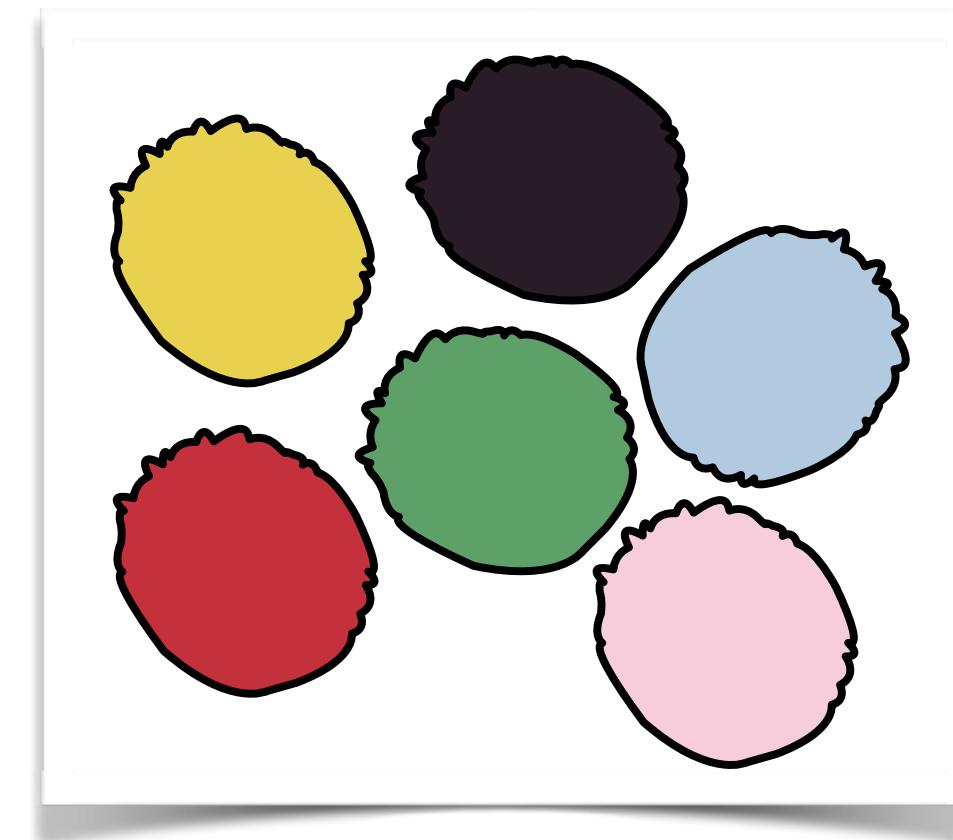
# concreteness



hungry



flat

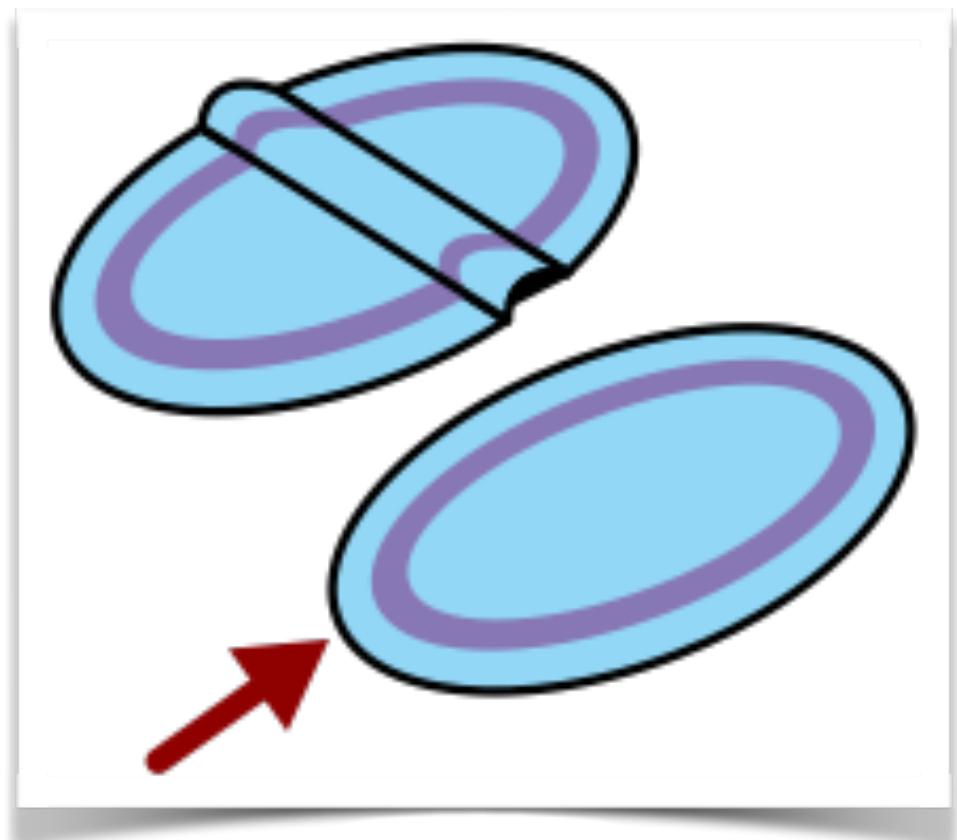


pom poms

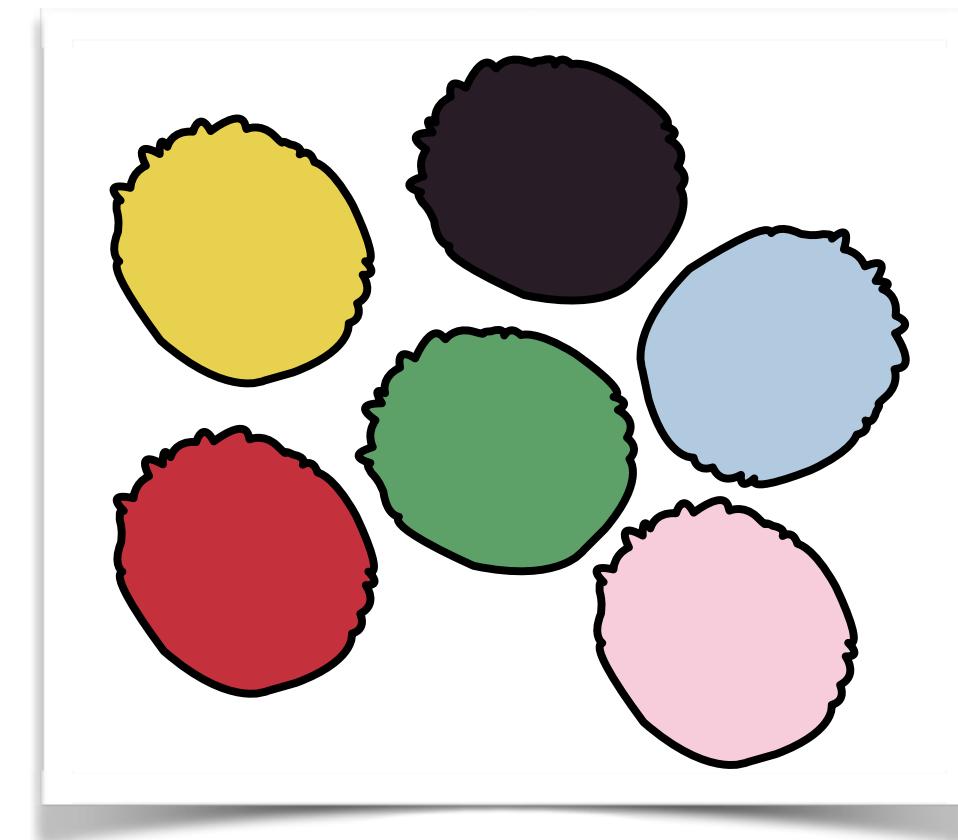
# concreteness



hungry



flat



pom poms

less concrete →

# Icon sets - considerations

## Visualization and Cognitive load:

McDougall et al. described three main characteristics

1. concreteness - visual metaphor

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# Icon sets - considerations

## Visualization and Cognitive load:

McDougall et al. described three main characteristics

1. concreteness
2. complexity - the level of details

# complexity

# complexity



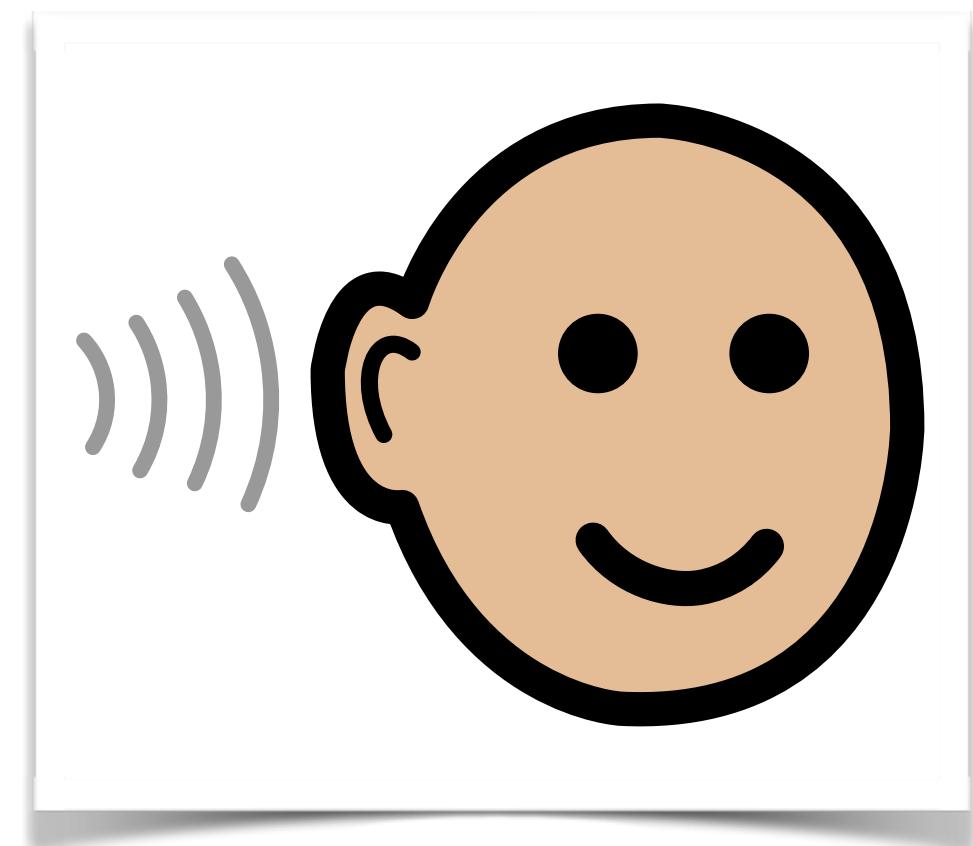
# complexity



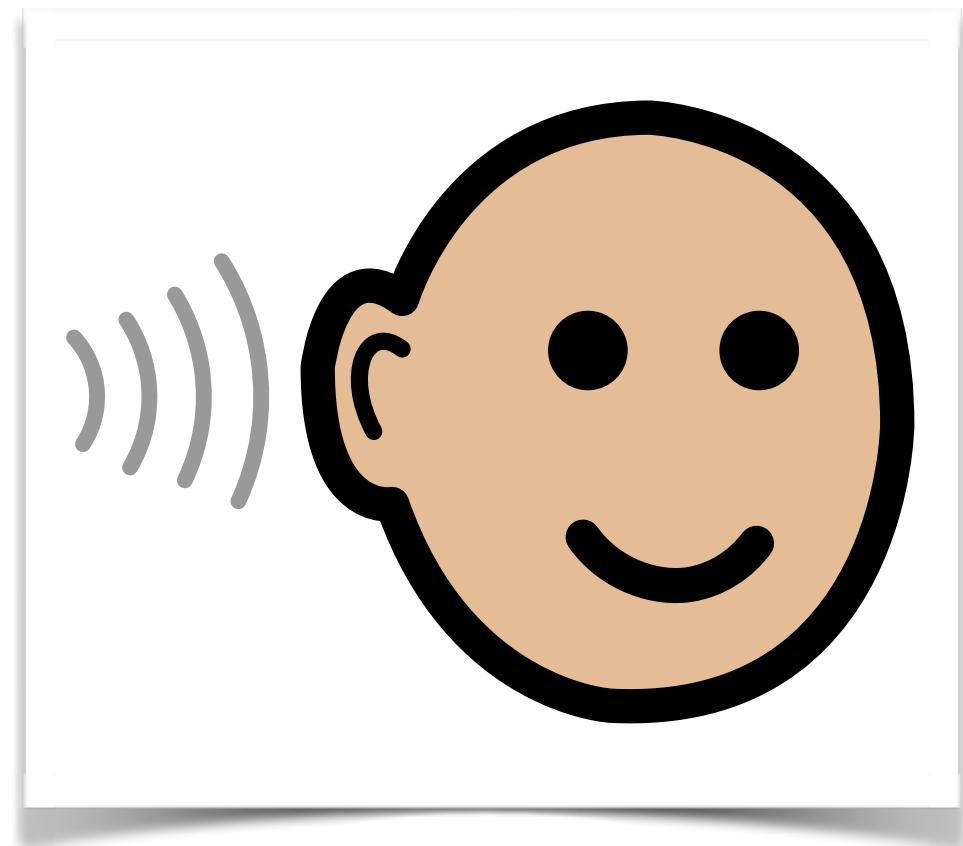
messy

# complexity

# complexity



# complexity



listen

# complexity

# complexity



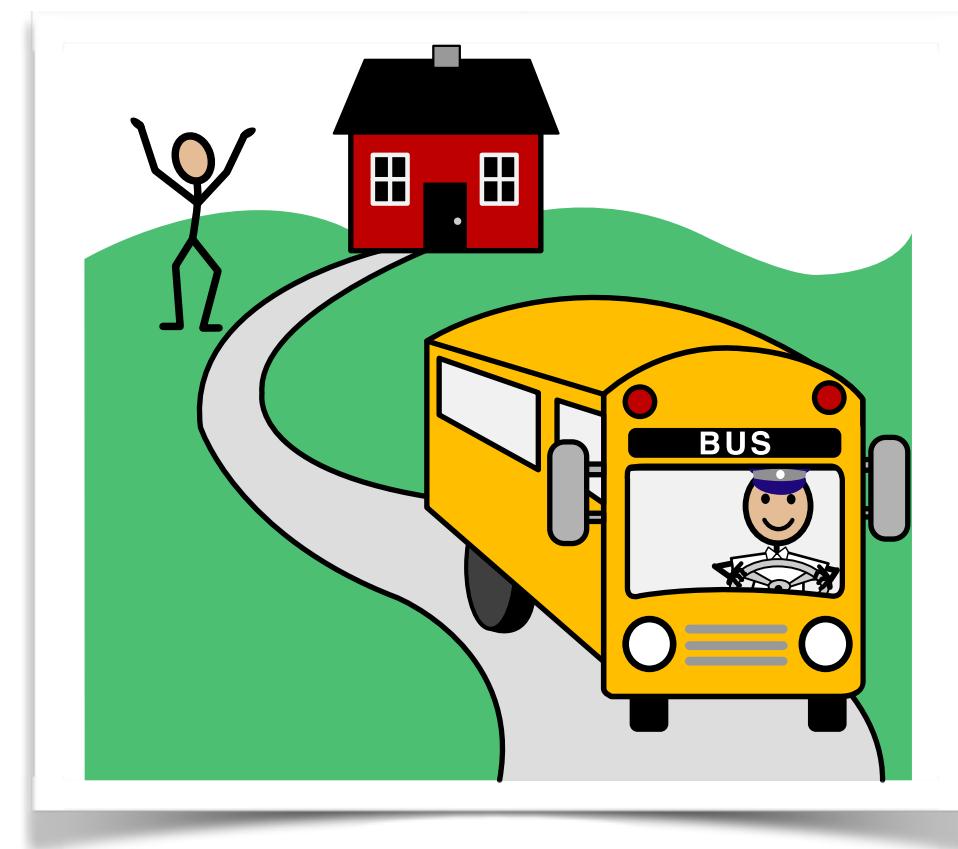
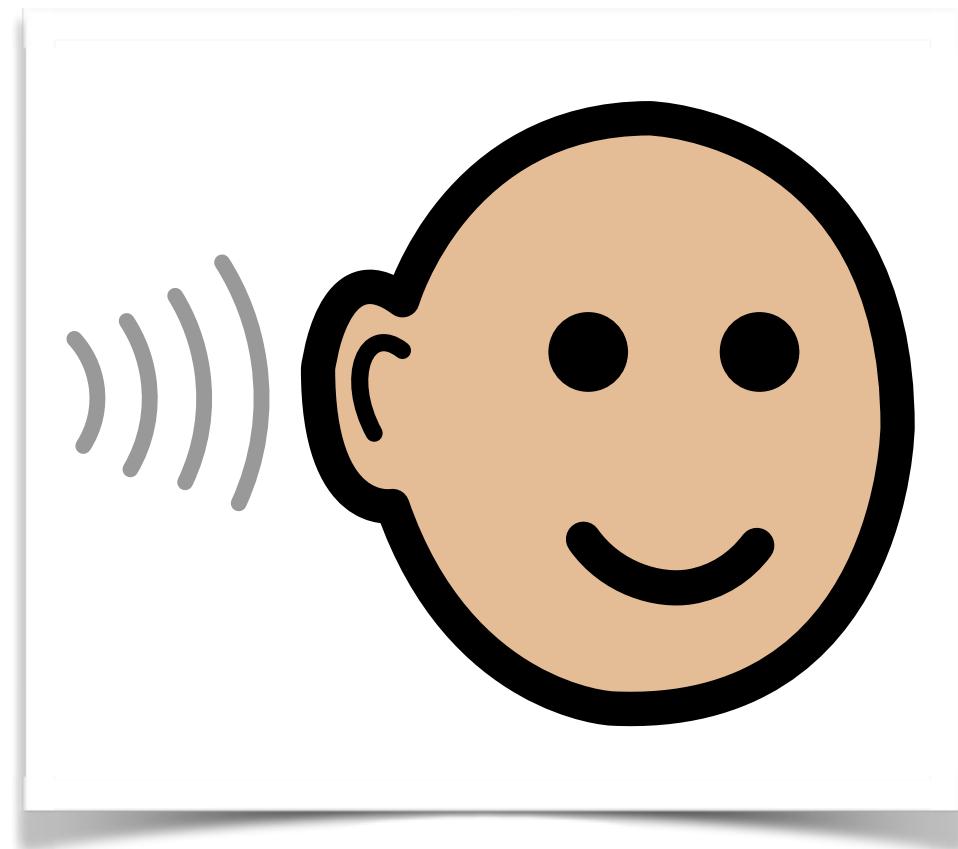
# complexity



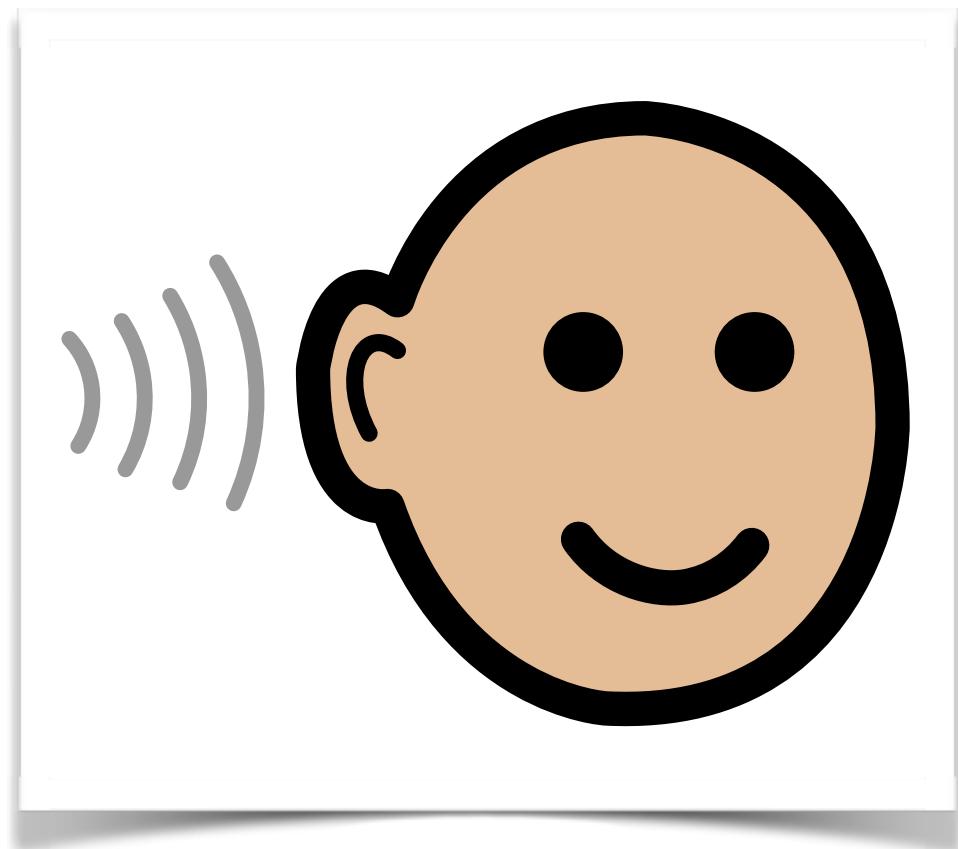
miss bus

# complexity

# complexity



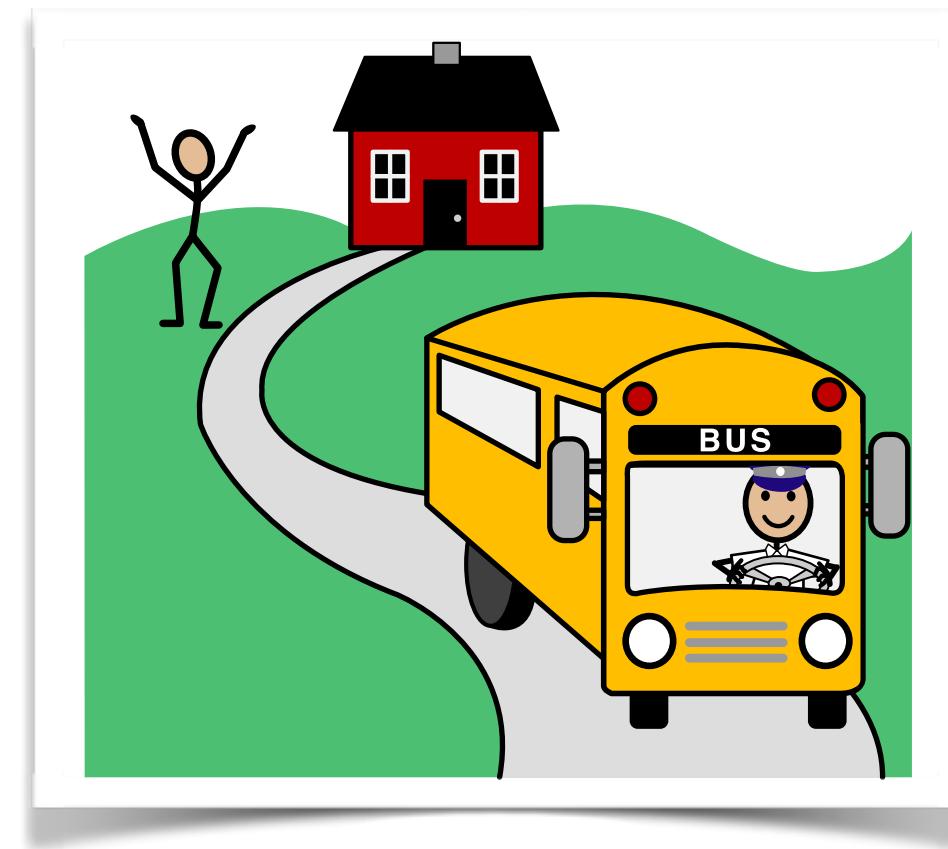
# complexity



listen

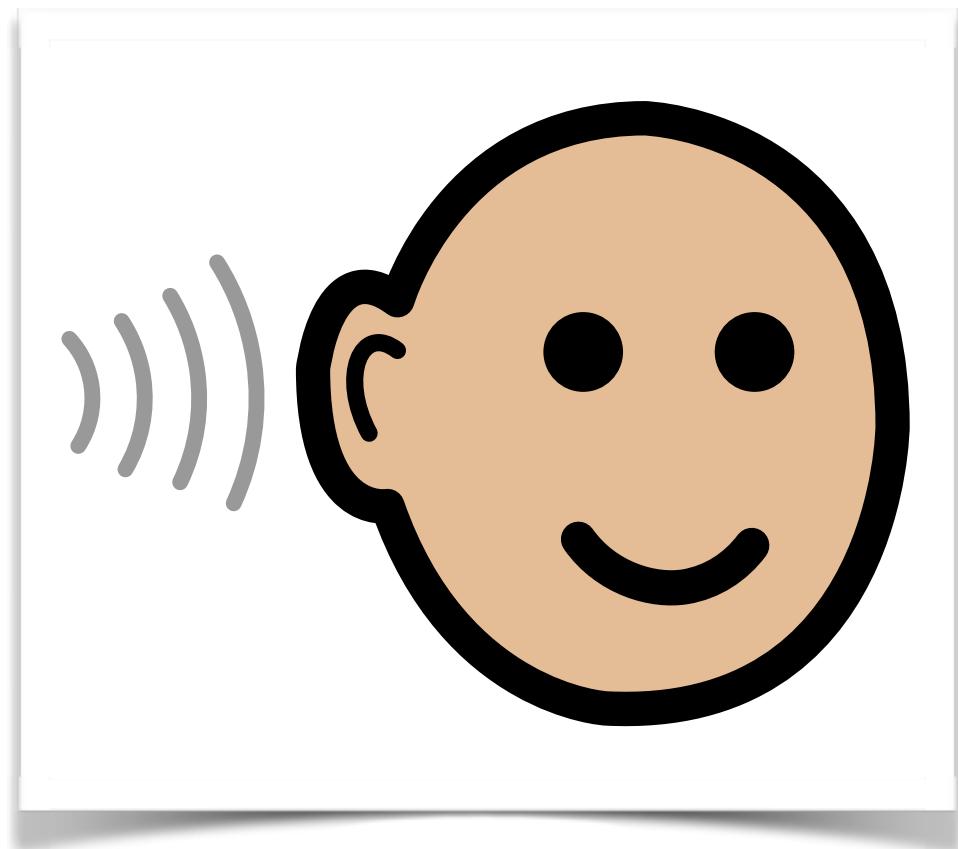


messy



miss bus

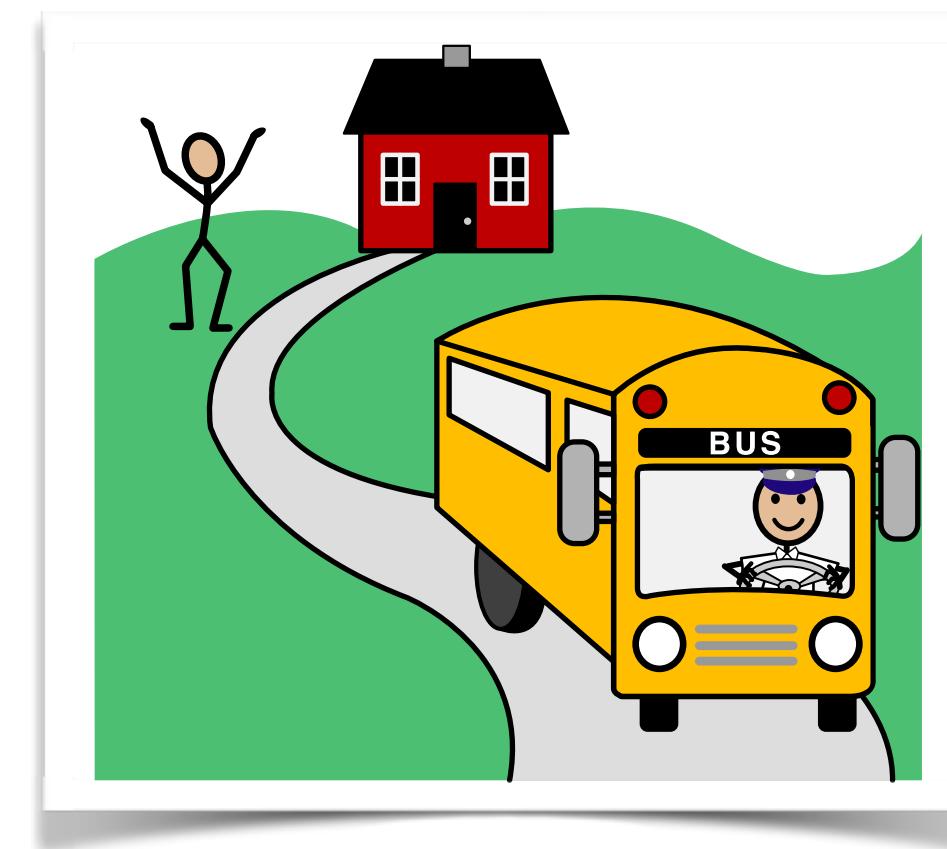
# complexity



listen



messy



miss bus

more complex

# Icon sets - considerations

## Visualization and Cognitive load:

According to McDougall et al. there are several characteristics that are important when choosing an icon set:

1. concreteness
2. complexity - the level of details

# Icon sets - considerations

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According to McDougall et al. there are several characteristics that are important when choosing an icon set:

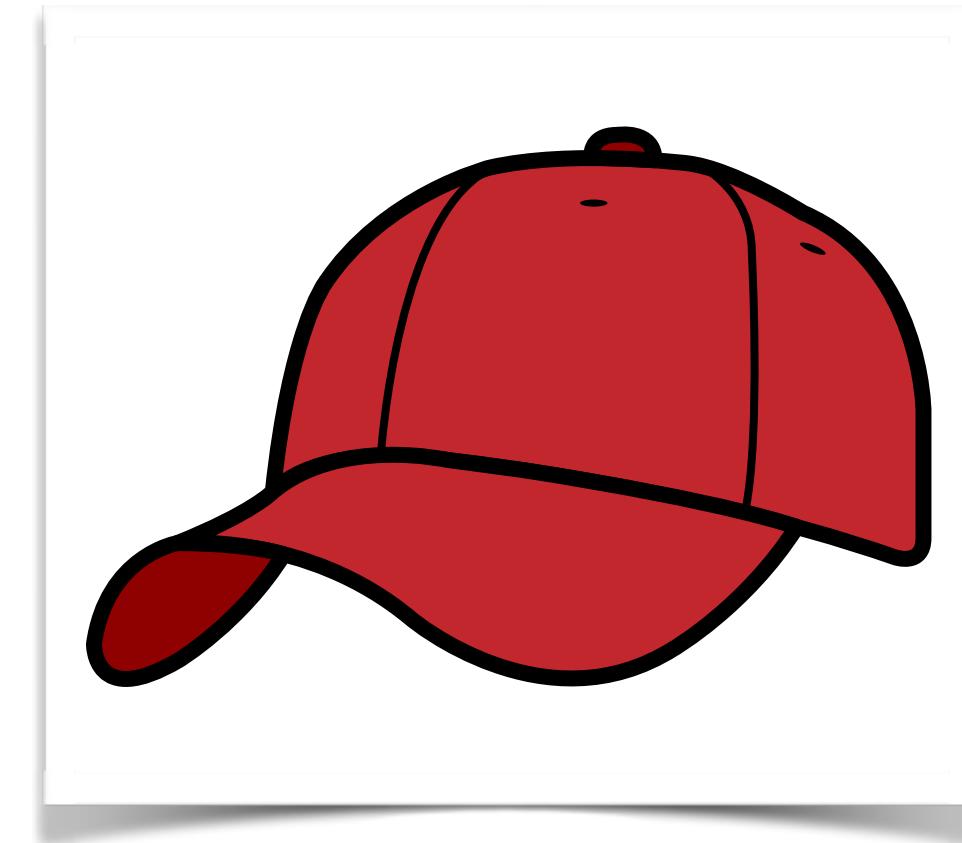
1. concreteness
2. complexity
3. distinctiveness - less confusing in context of other icons

It's sunny outside  
I wear a \_\_ on my head

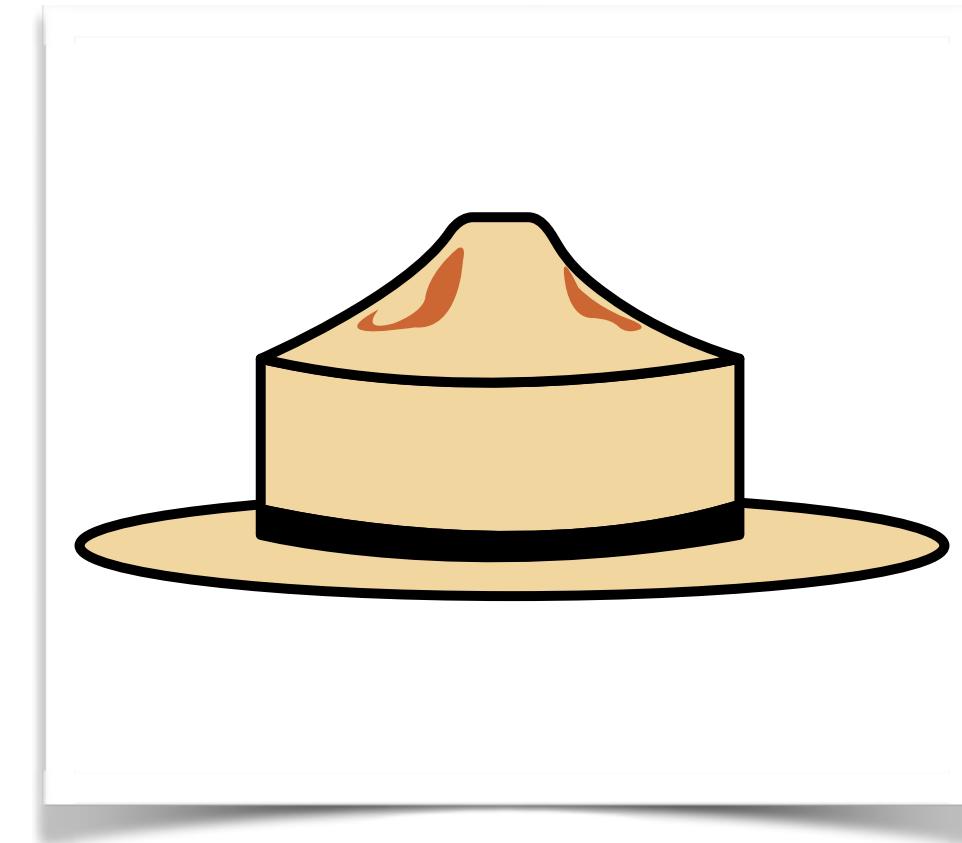
It's sunny outside  
I wear a \_\_ on my head



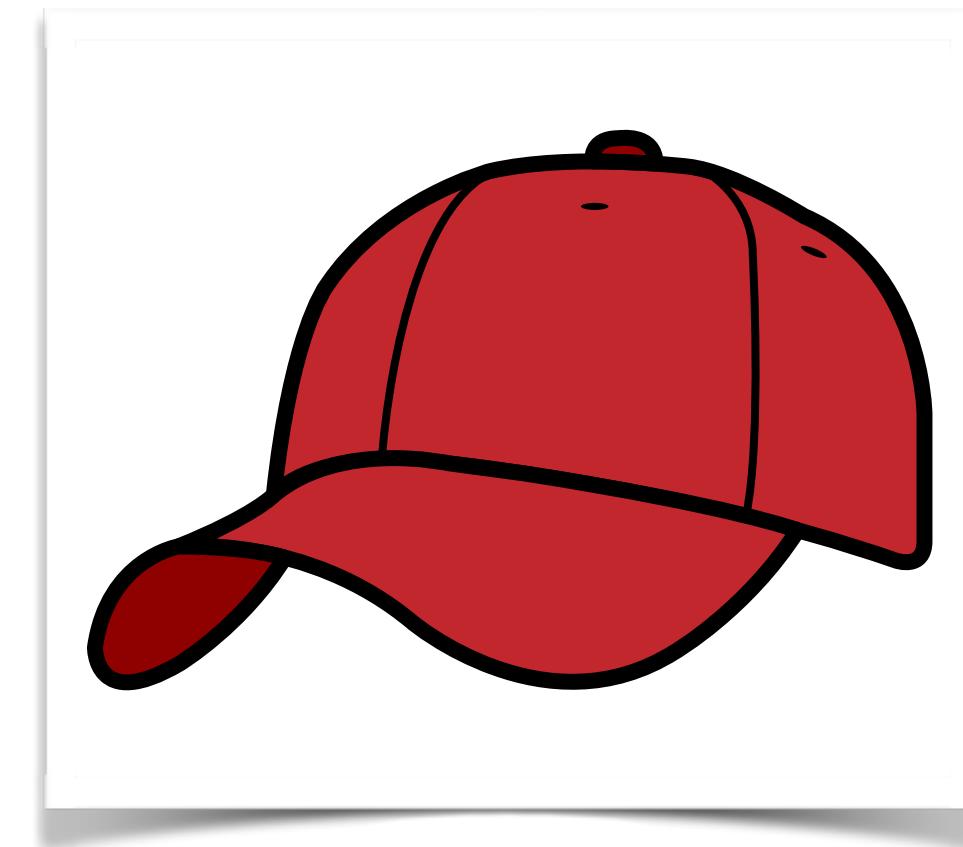
It's sunny outside  
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It's sunny outside  
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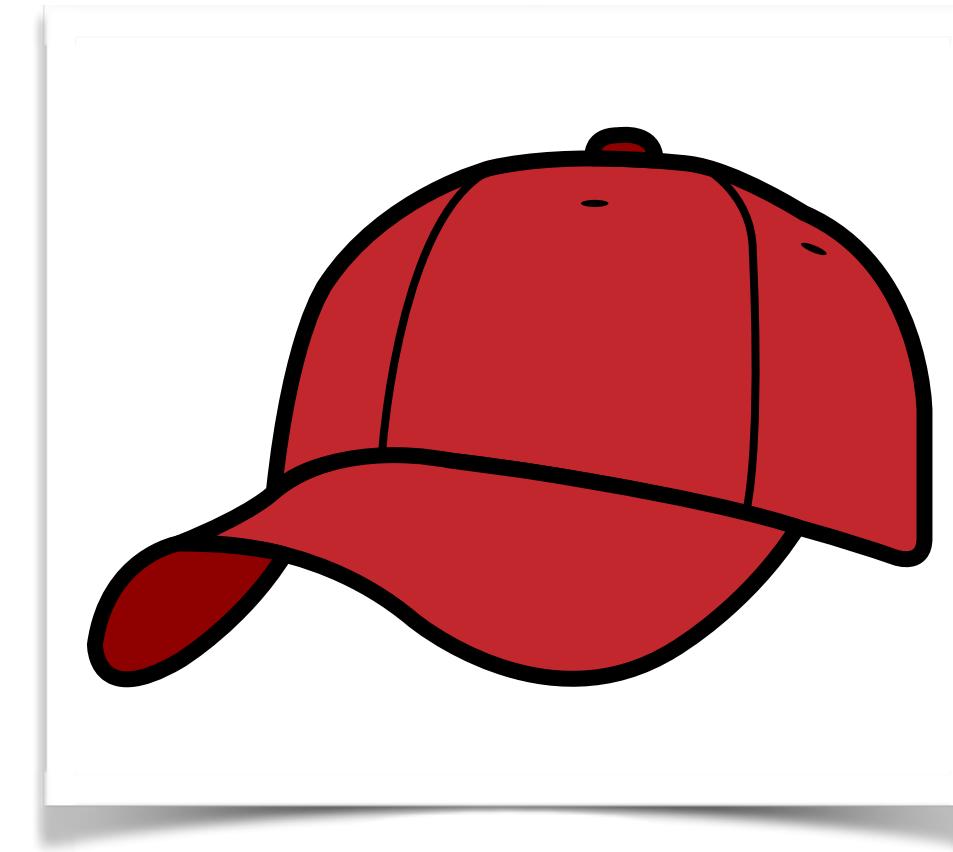
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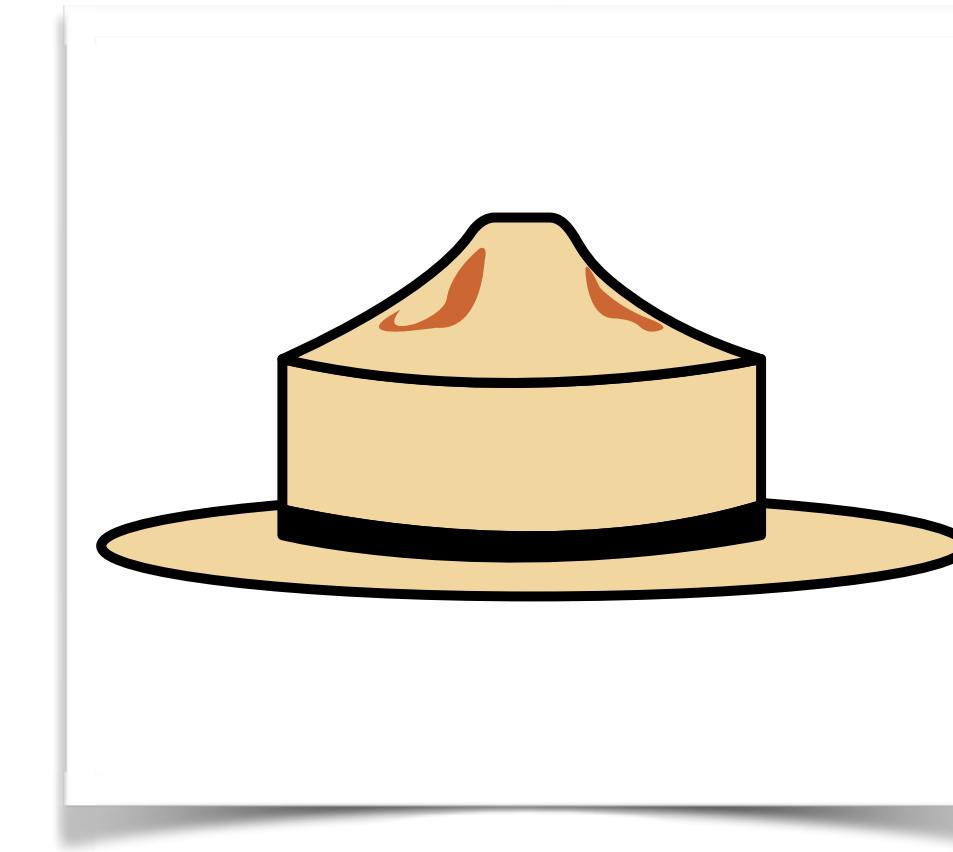
It's sunny outside  
I wear a \_\_ on my head



dodgers hat



baseball hat

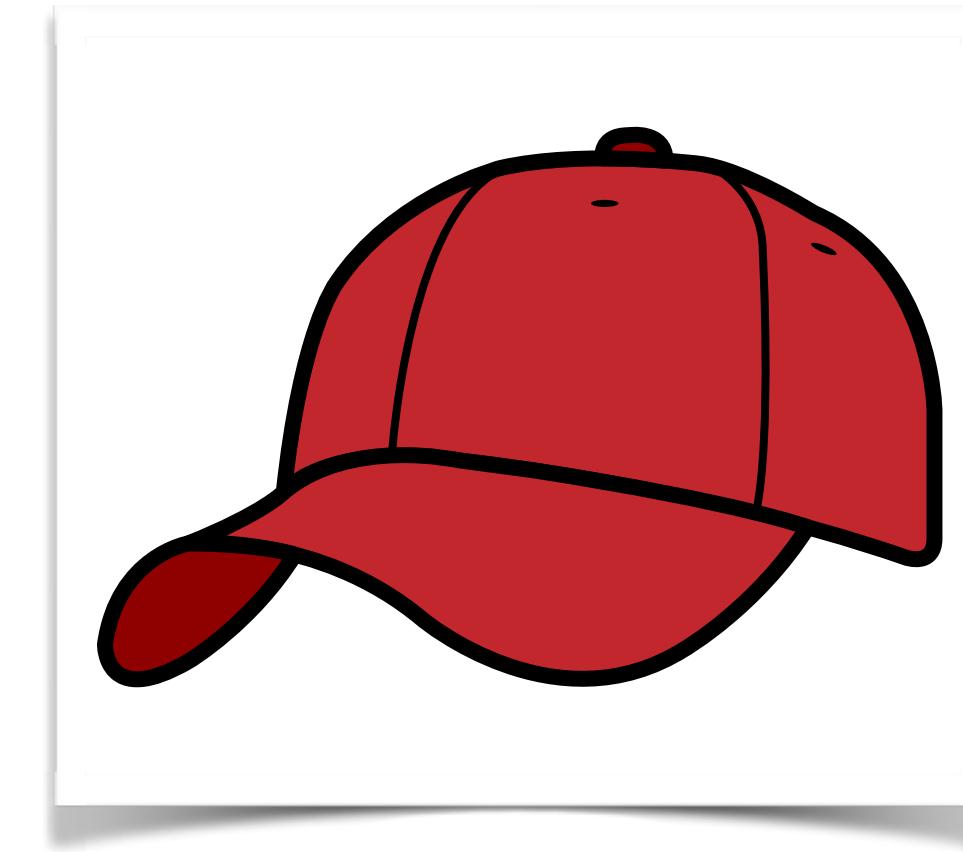


park ranger hat

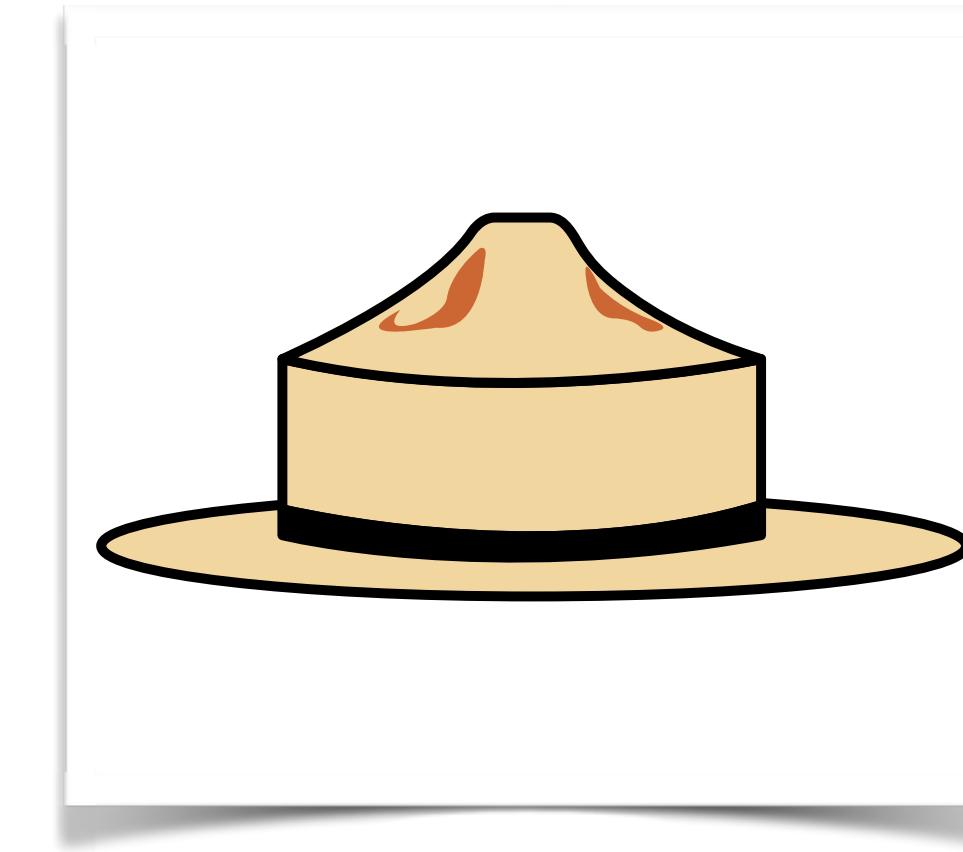
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baseball hat

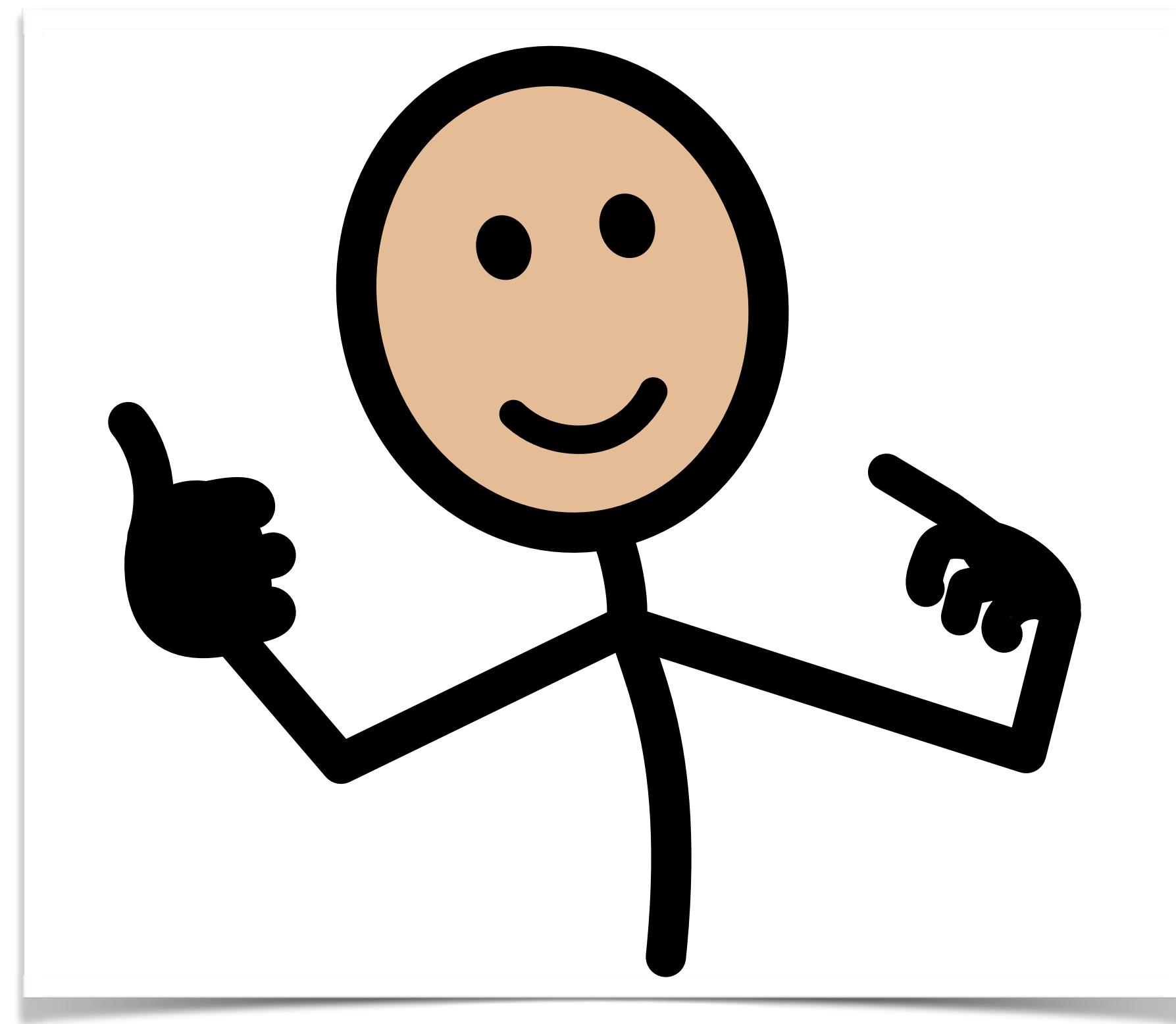


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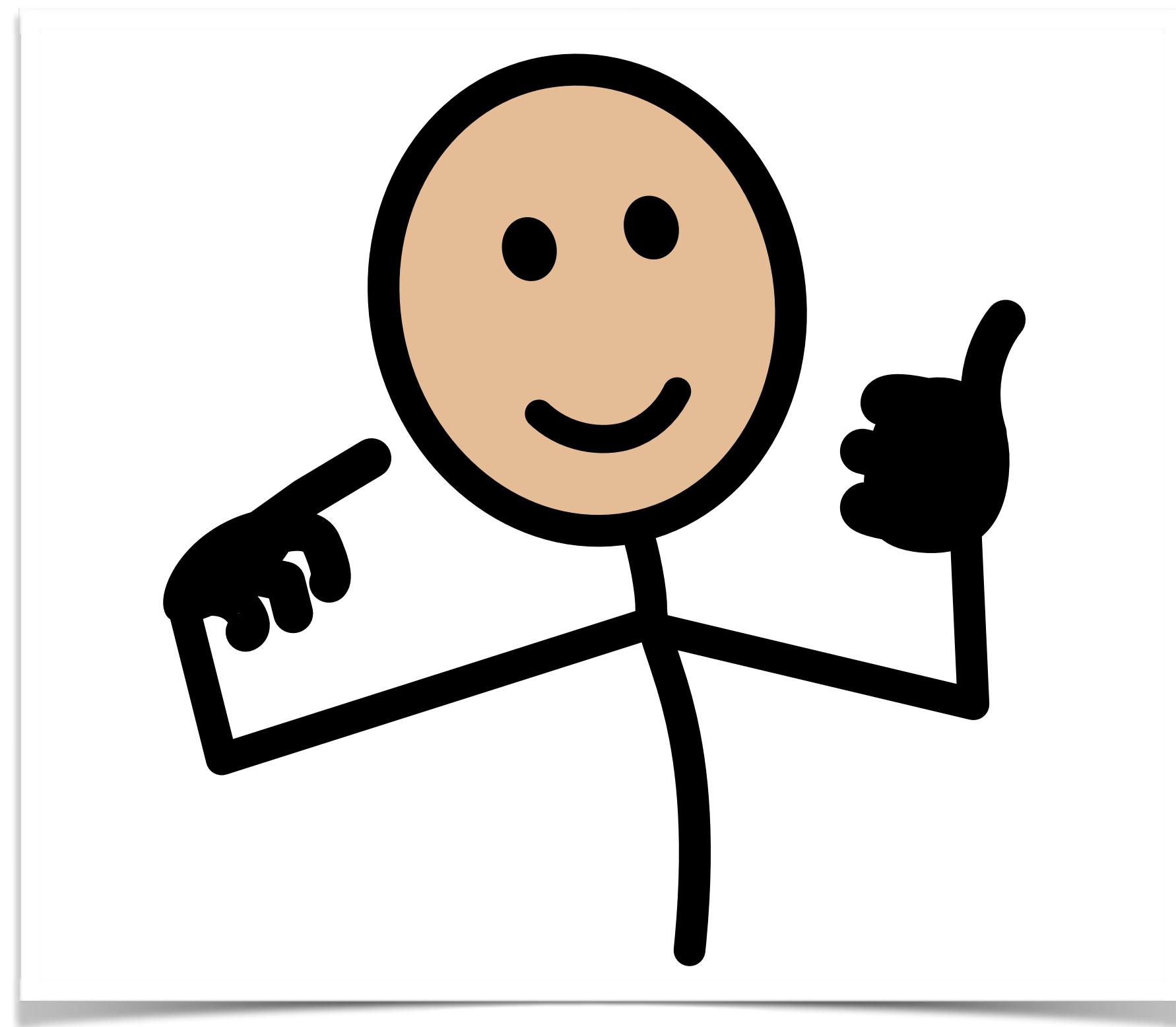
too close on semantic axis

I am fine

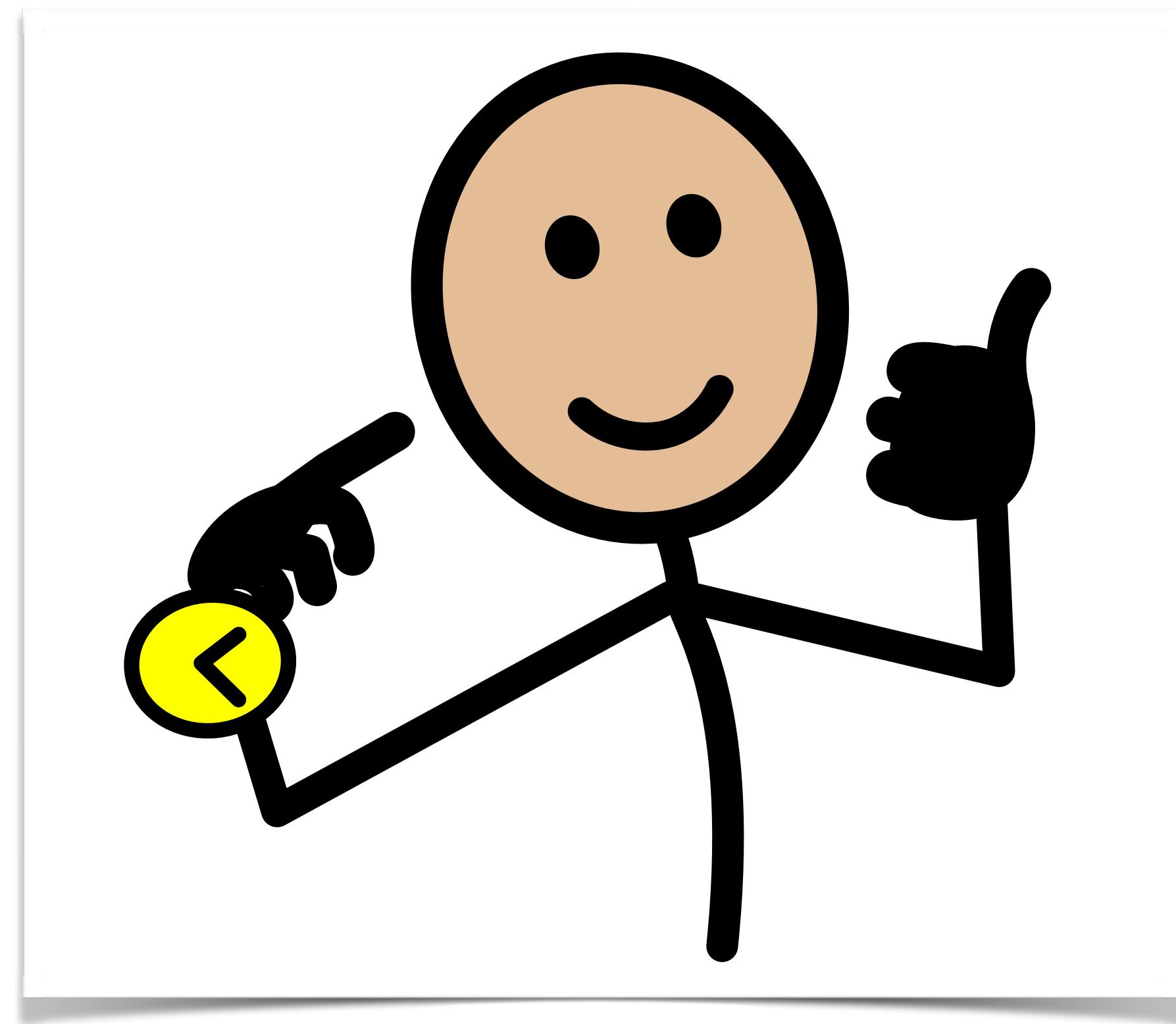
# I am fine



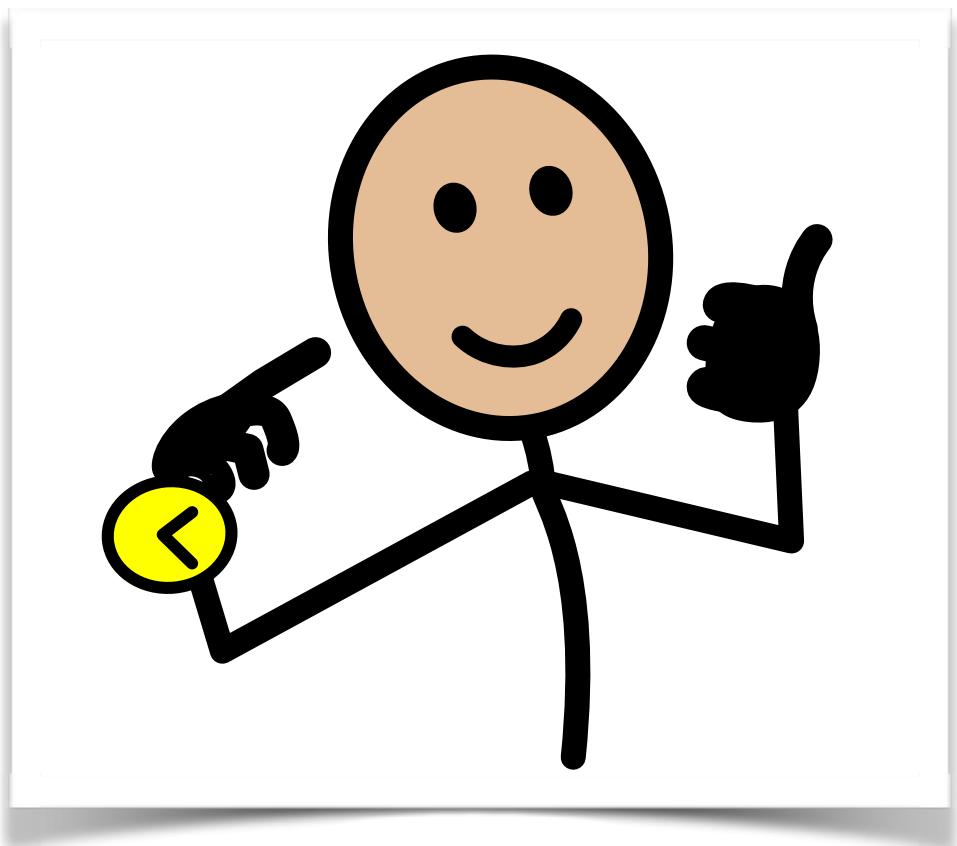
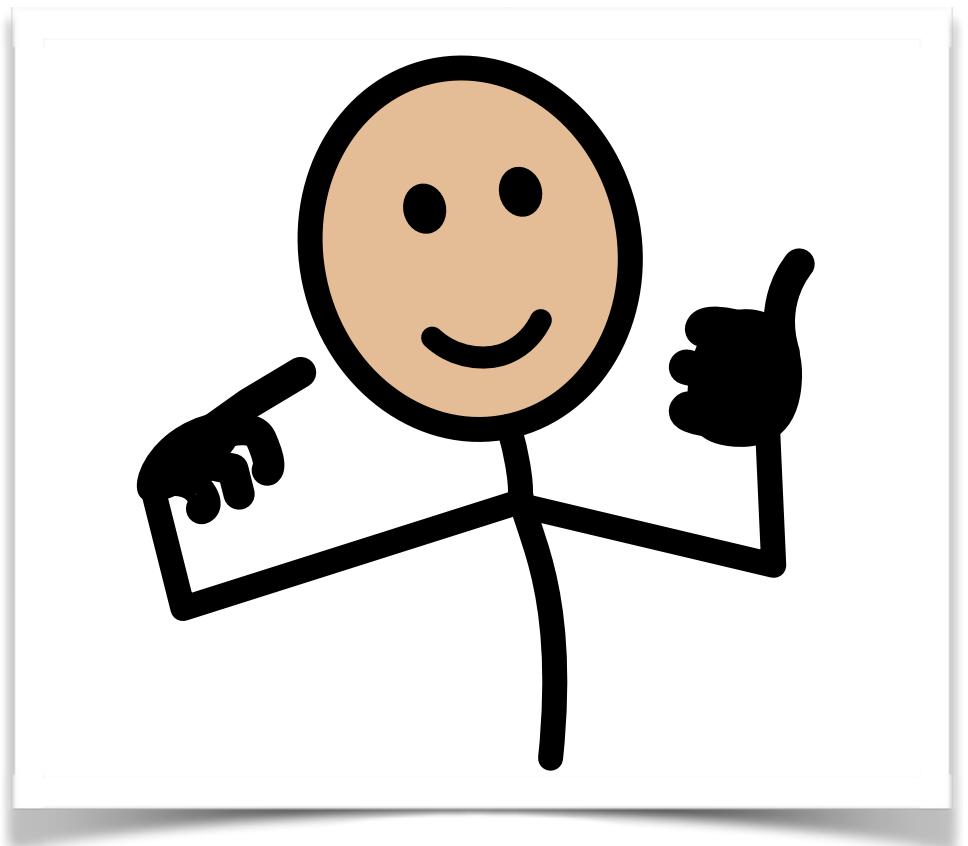
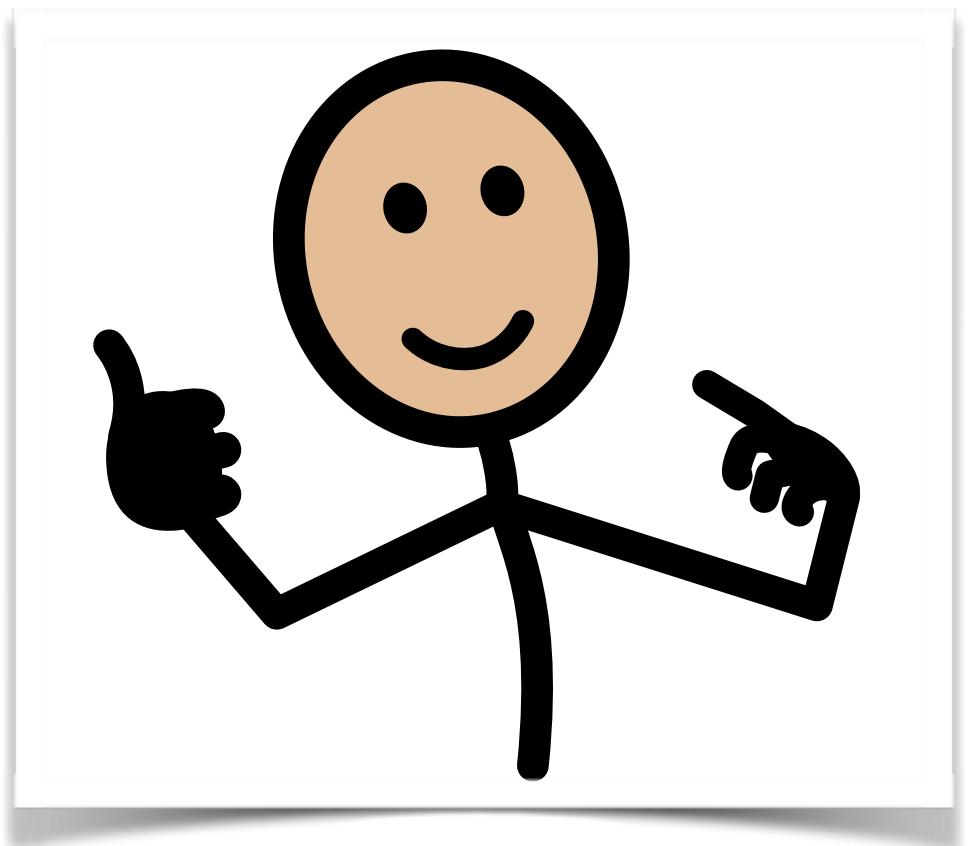
# I am fine



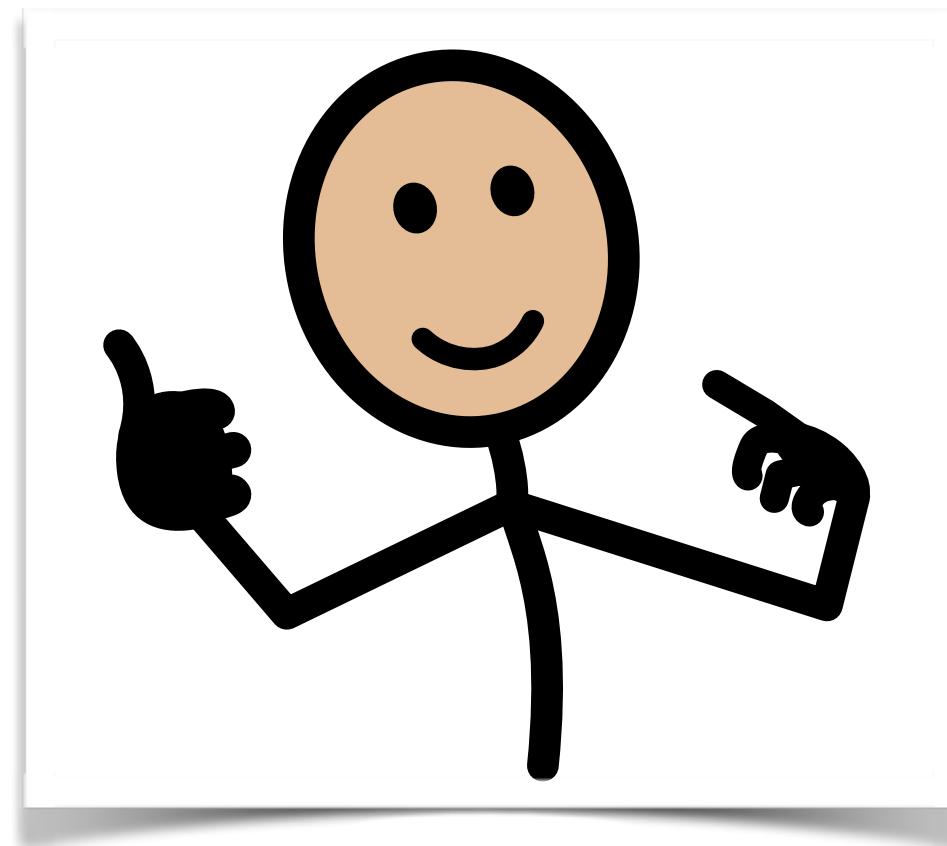
# I am fine



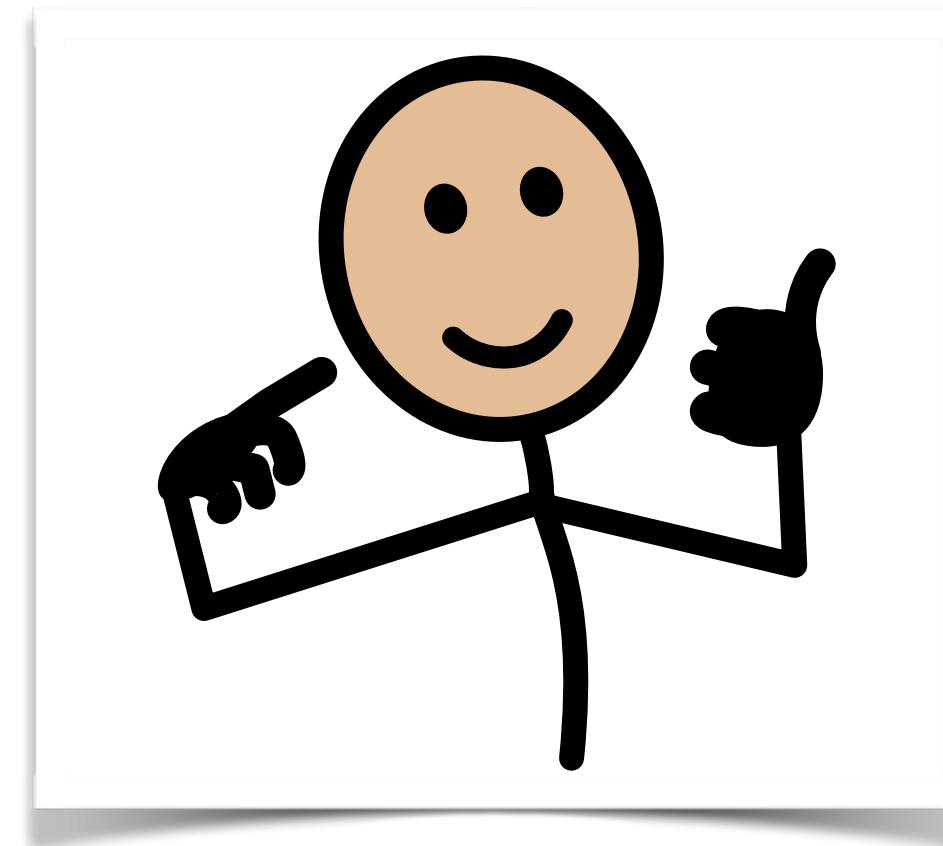
# I am fine



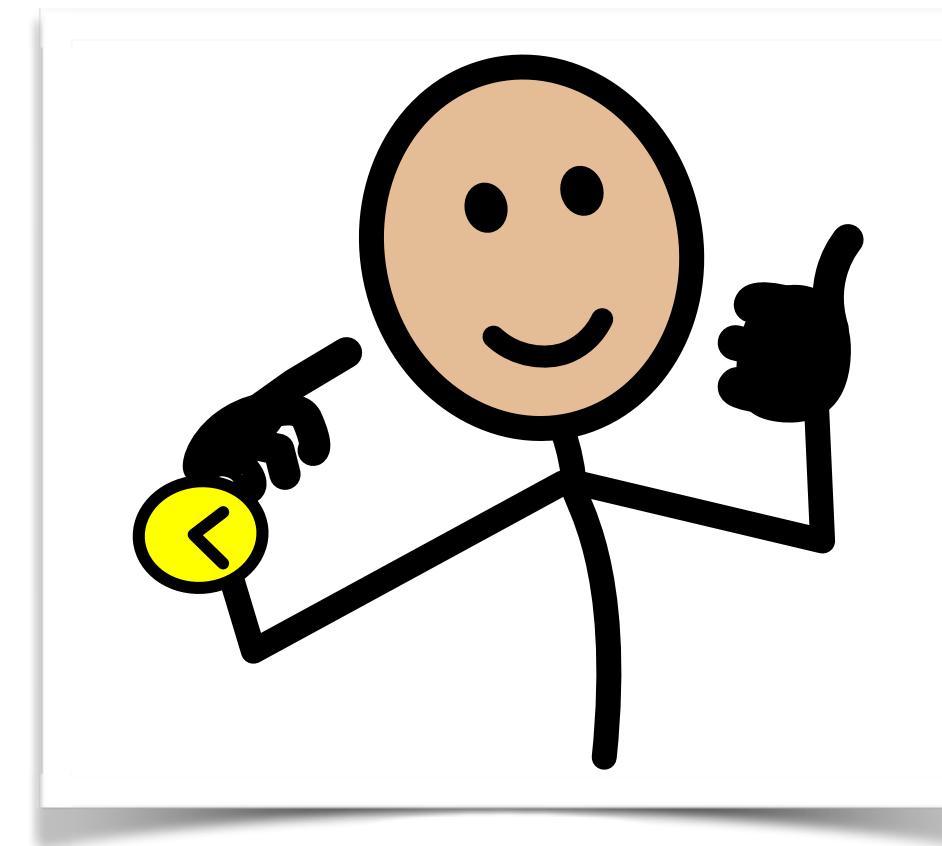
# I am fine



I got it



I am fine

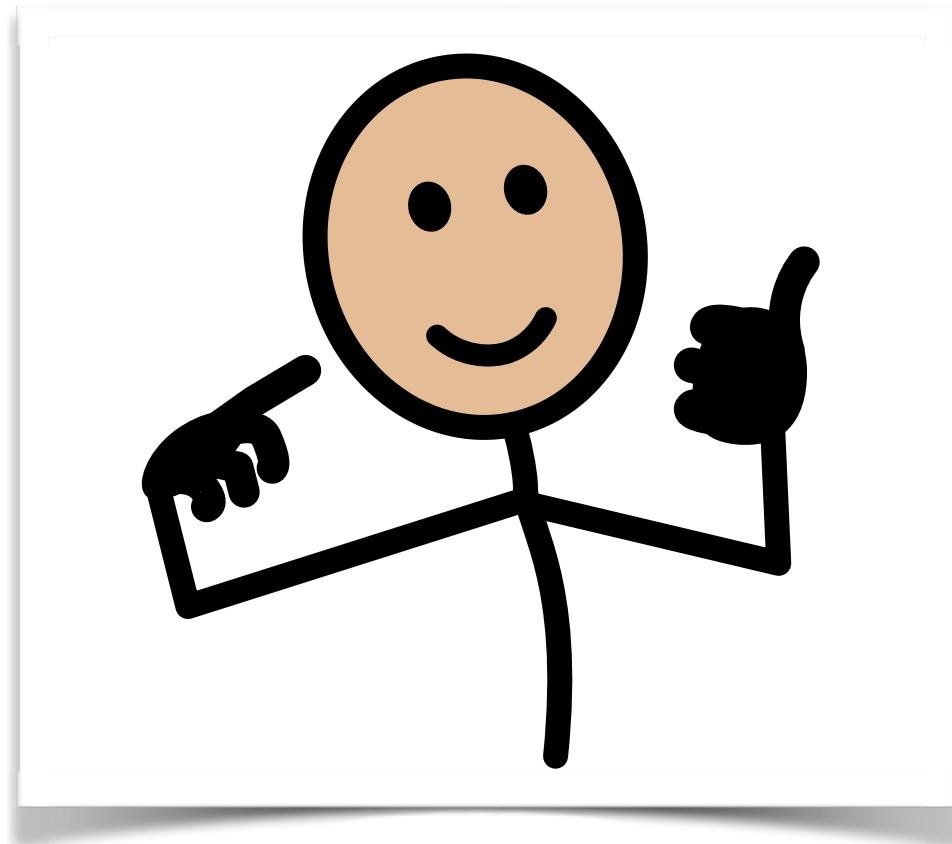


I am ready

# I am fine



I got it



I am fine

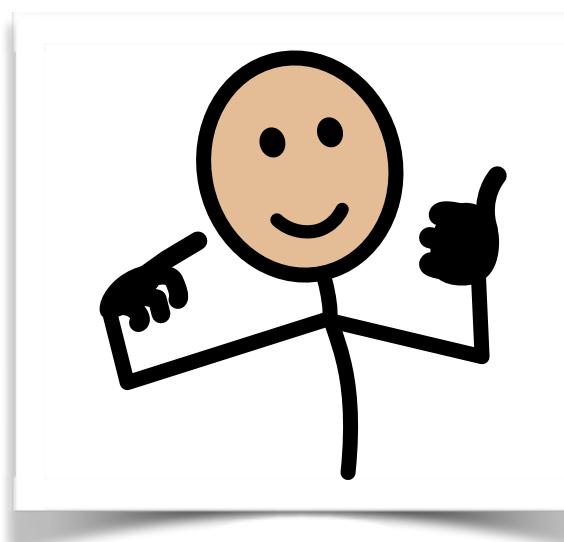


I am ready

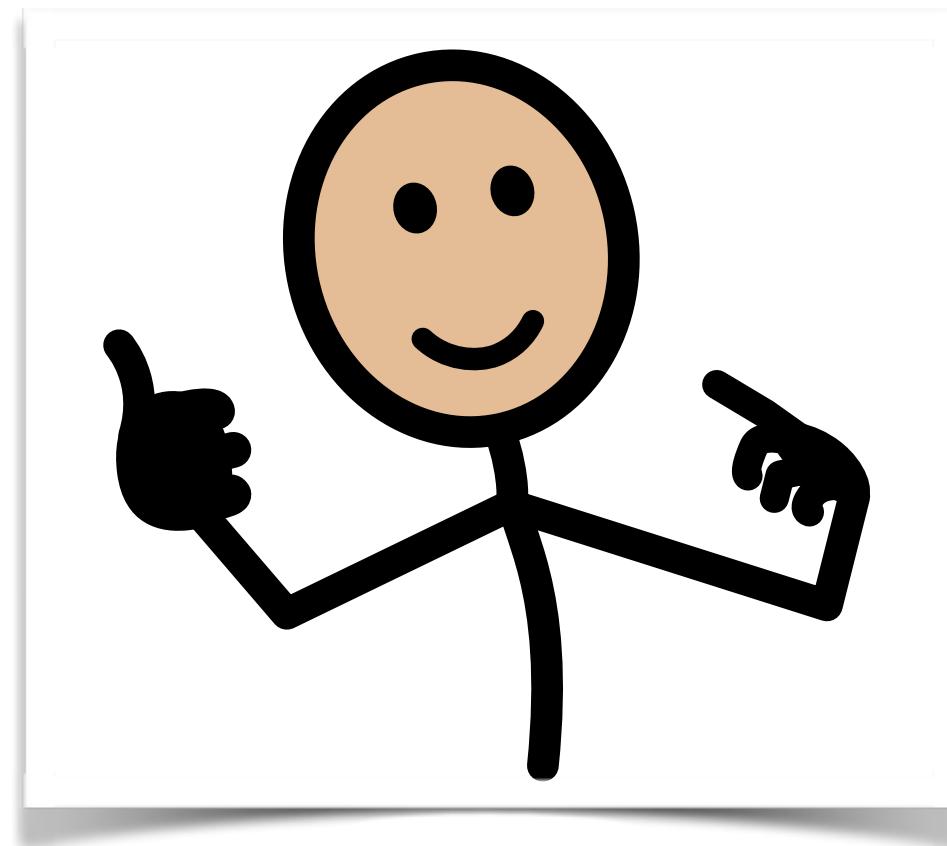
too close on shape axis

ideally we choose a better icon

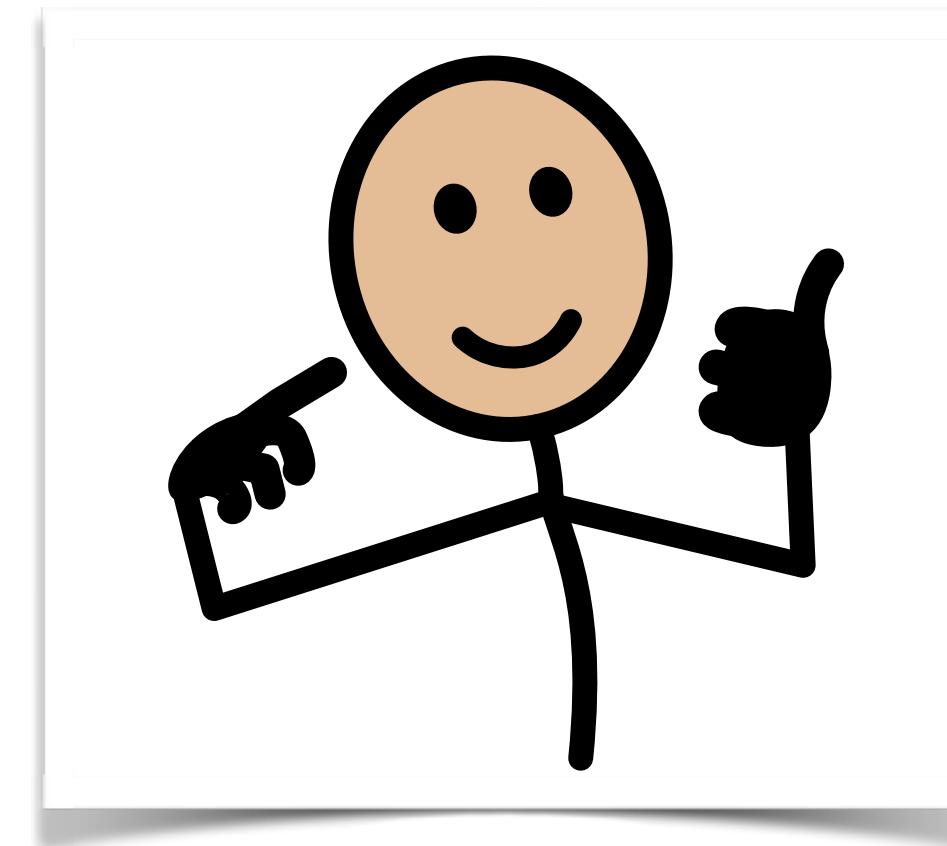
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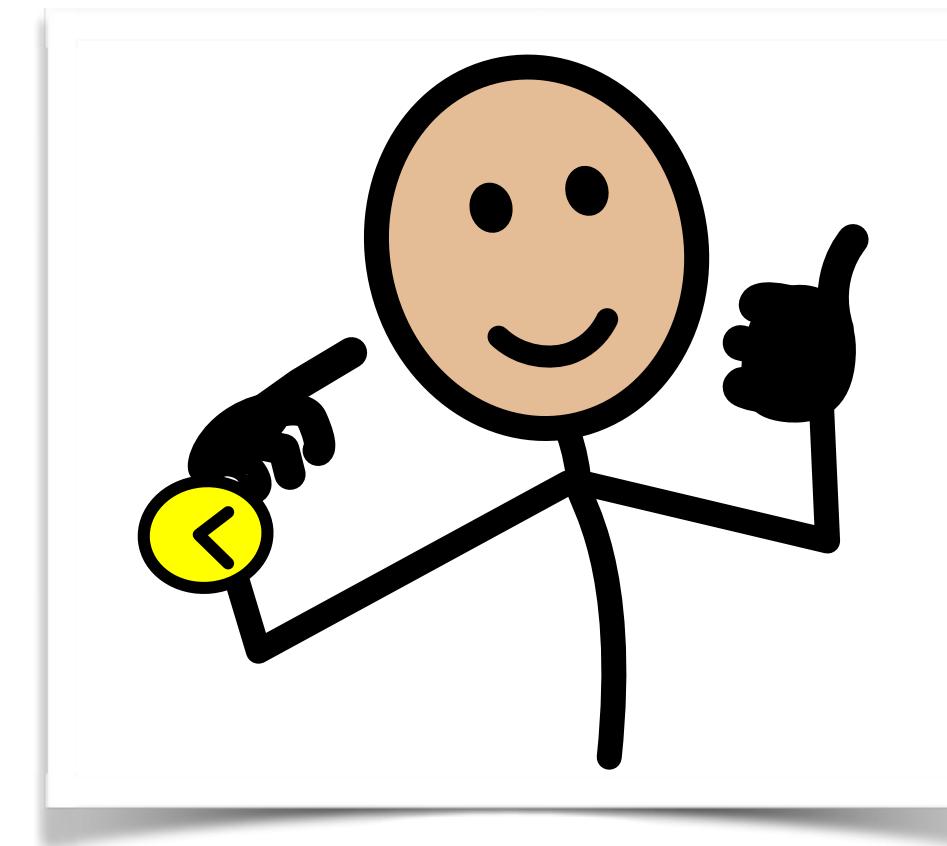
# I am fine



I got it

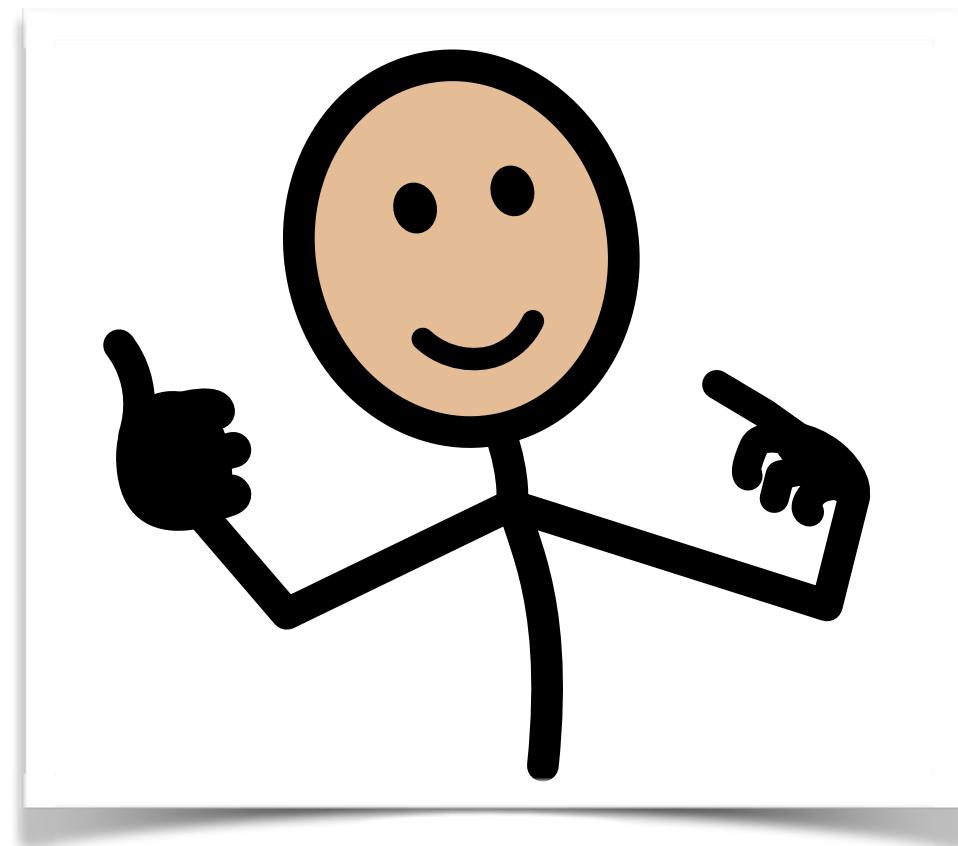


I am fine



I am ready

# I am fine



I got it



I am fine



I am ready

# Icon sets - considerations

## Visualization and Cognitive load:

According to McDougall et al. there are several characteristics that are important when choosing an icon set:

1. concreteness
2. complexity
3. distinctiveness - less confusing in context of other icons

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# Icon sets - examples

## Picture Communication Symbol set

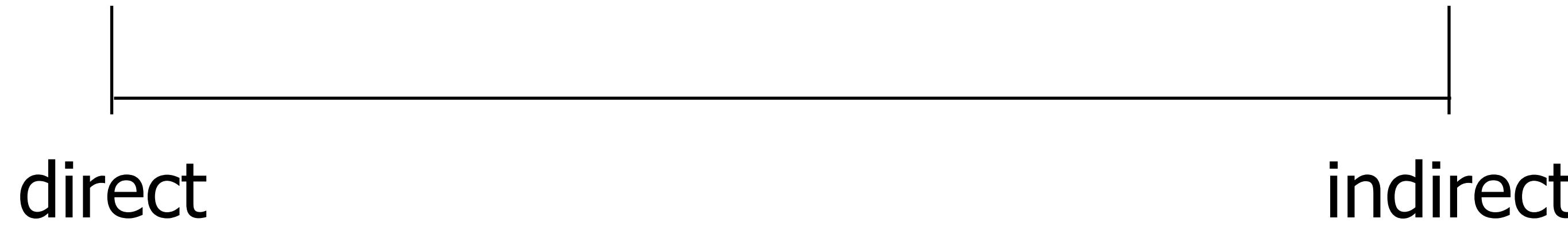
12,000 symbols that contain country specific libraries of icons as well

## SymbolStix icon set

34,000 symbols and is incorporated in news2you that provides adult newscast of icons

# Selection Modality:

# Selection Modality:



# Selection Modality:



# Selection Modality:



# Selection Modality:



# Selection Modality:



# Selection Modality:



# Selection Modality:

is dictated by mobility on the screen



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is dictated by mobility on the screen



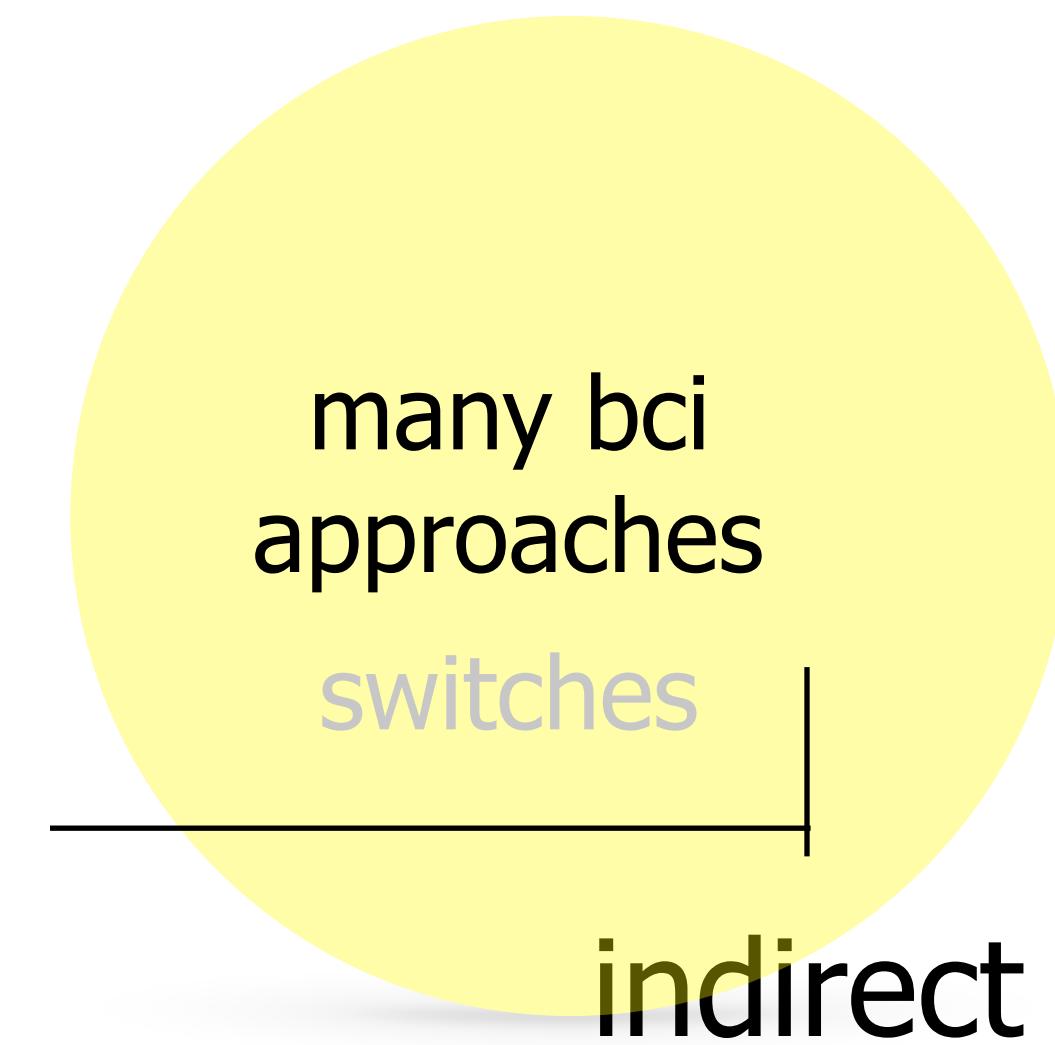
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is dictated by mobility on the screen



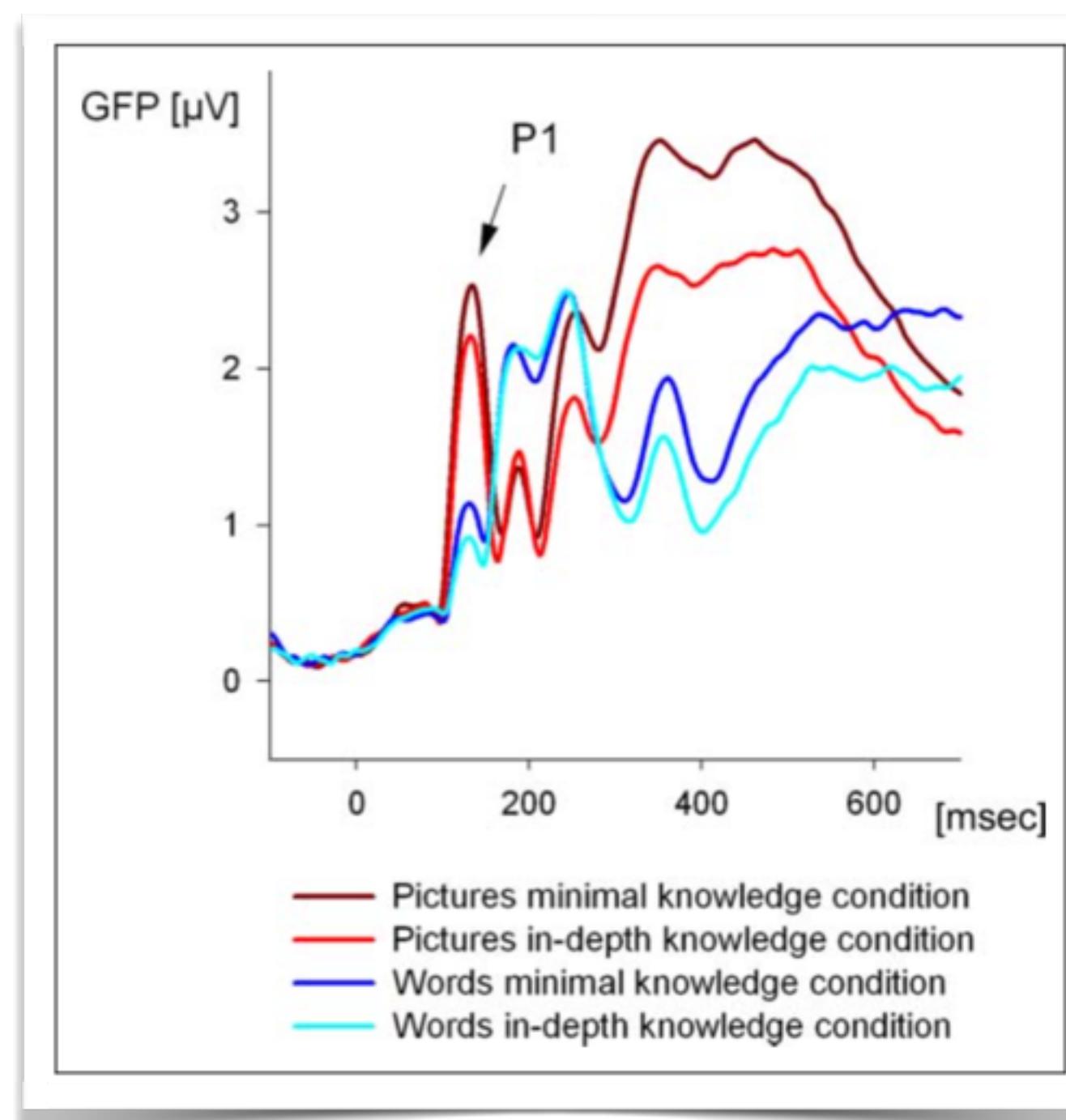
# Selection Modality:

is dictated by mobility on the screen

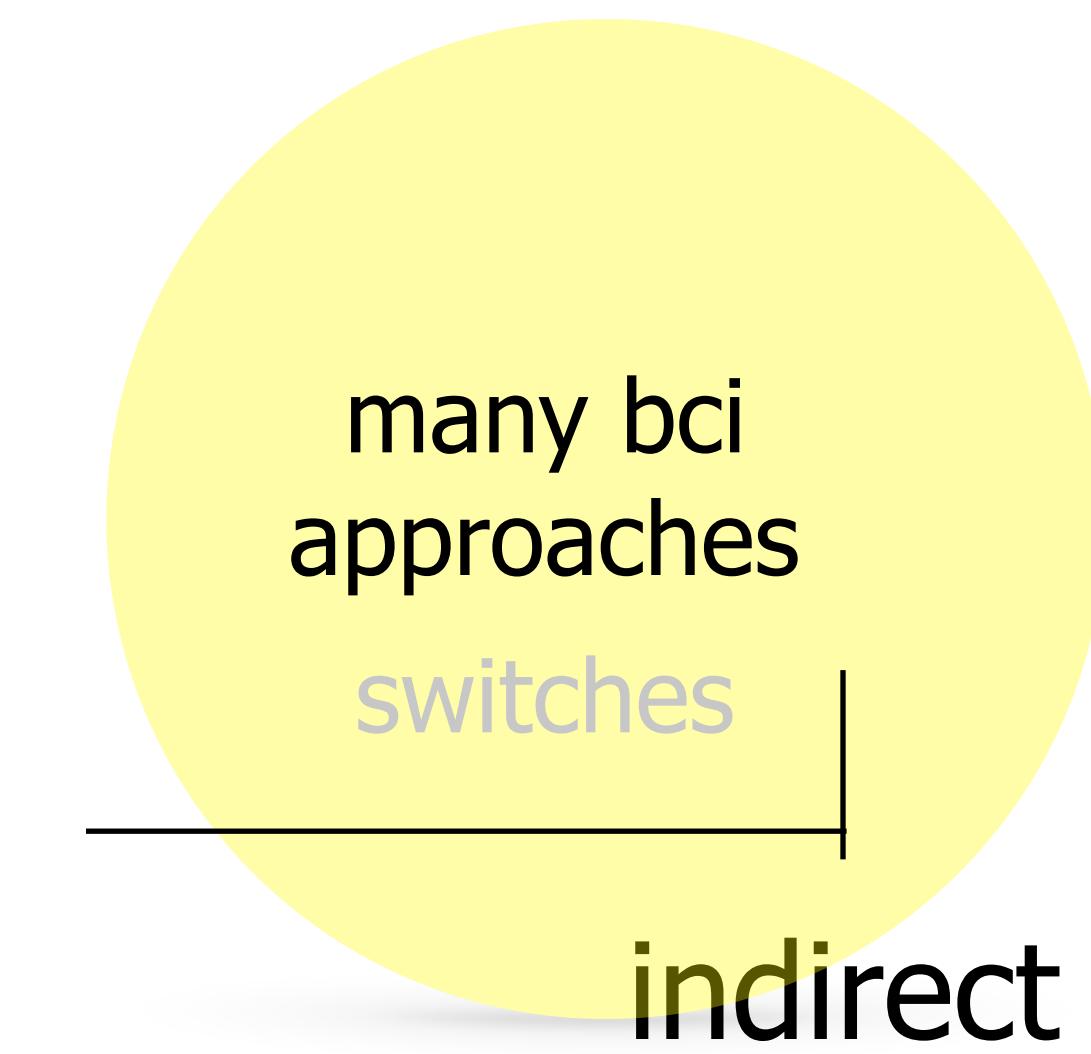


# Selection Modality:

is dictated by mobility on the screen

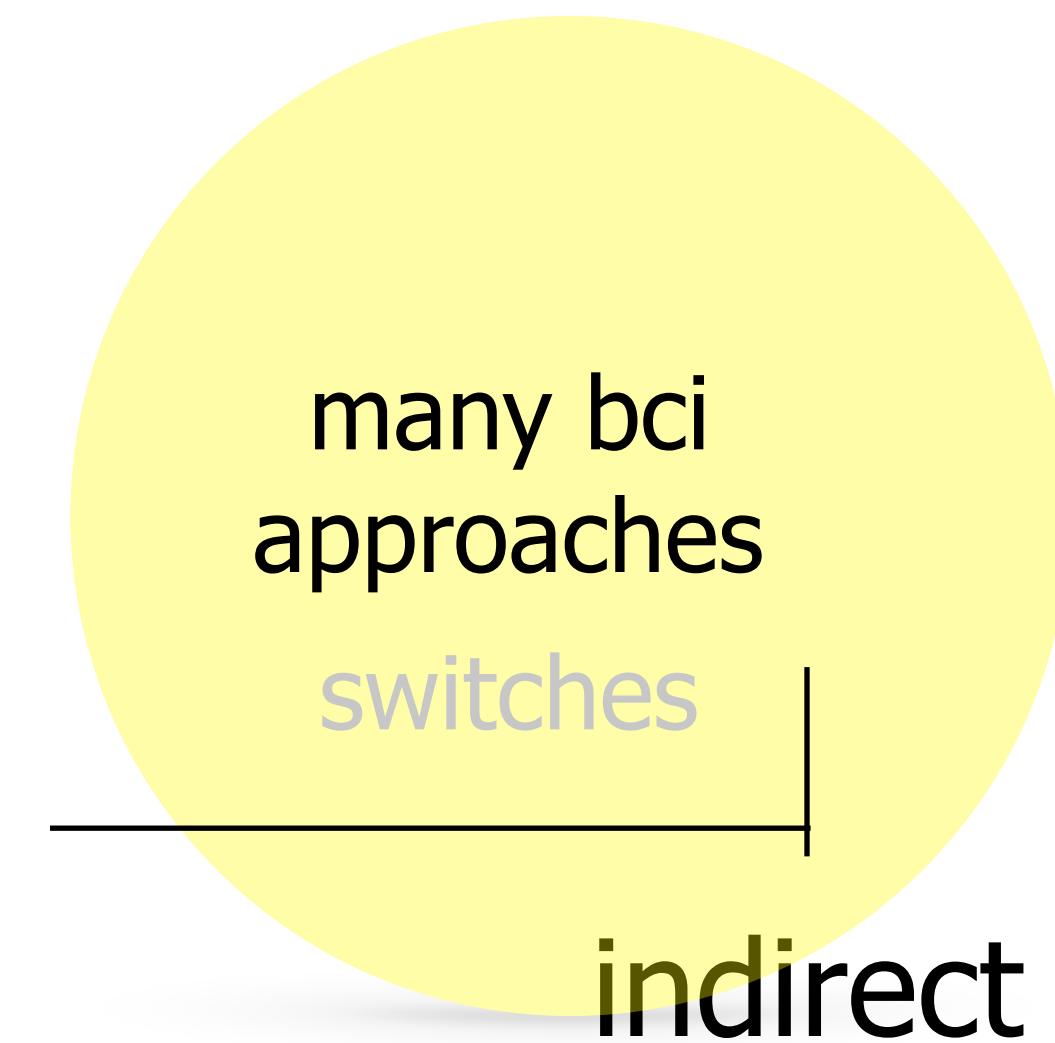


Milena et al. 2012



# Selection Modality:

is dictated by mobility on the screen



# Selection Modality:

is dictated by mobility on the screen

many bci  
approaches

switches

indirect

# Selection Modality:

is dictated by mobility on the screen



# Selection Modality:

is dictated by mobility on the screen



# Selection Modality:

is dictated by mobility on the screen



direct/indirect modality has crucial implications when choosing the **structure** of a system

# Icon sets - examples

## Picture Communication Symbol set

12,000 symbols that contain country specific libraries of icons as well

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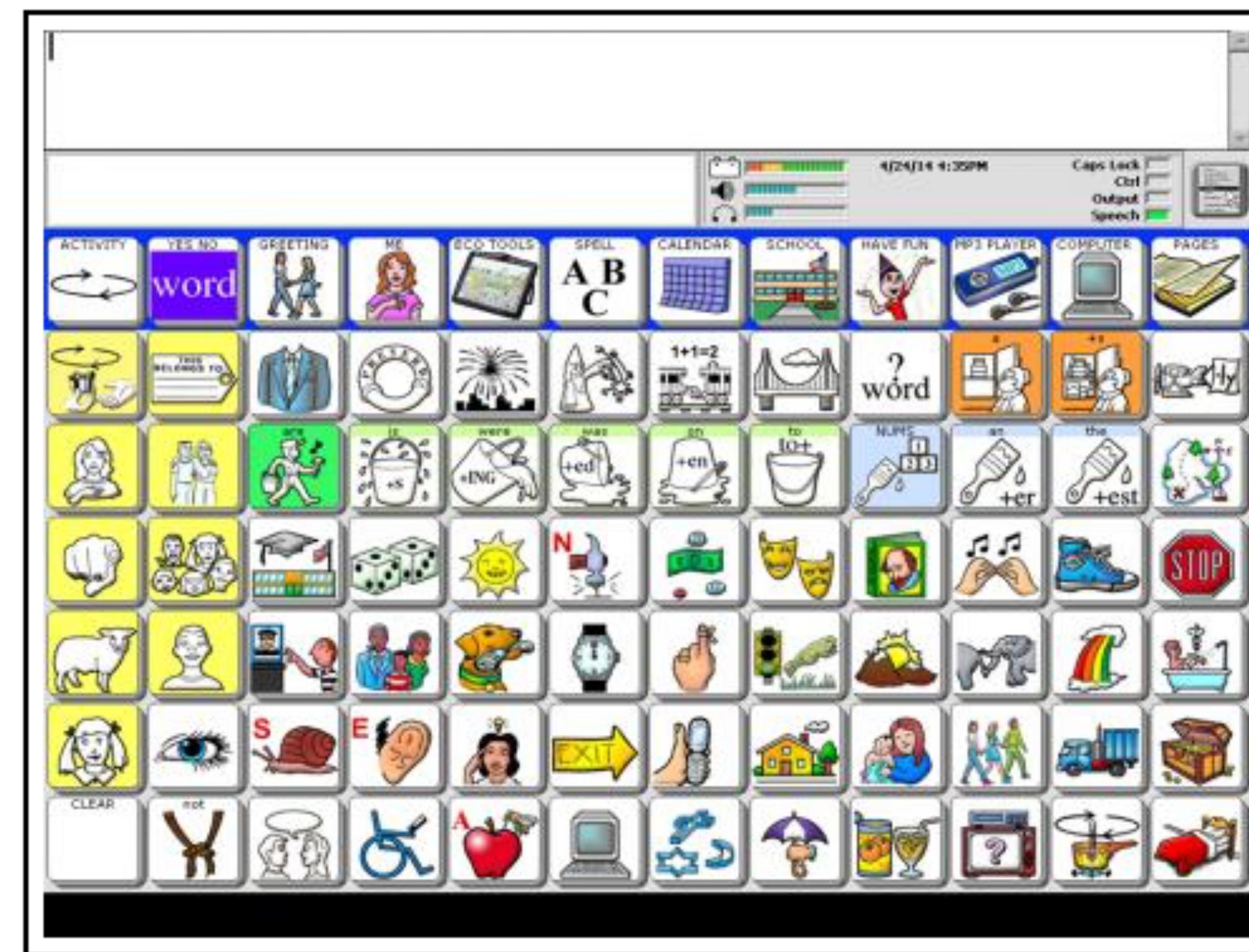
12,000 symbols that contain country specific libraries of icons as well

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34,000 symbols and is incorporated in news2you that provides adult newscast of icons

## MinSpeak icon set

# Minspeak system



[http://www.minspeak.com/teachers/otherresources.html#.Wv2yUS\\_MyL4](http://www.minspeak.com/teachers/otherresources.html#.Wv2yUS_MyL4)

# Minspeak system



# Minspeak system



eat:

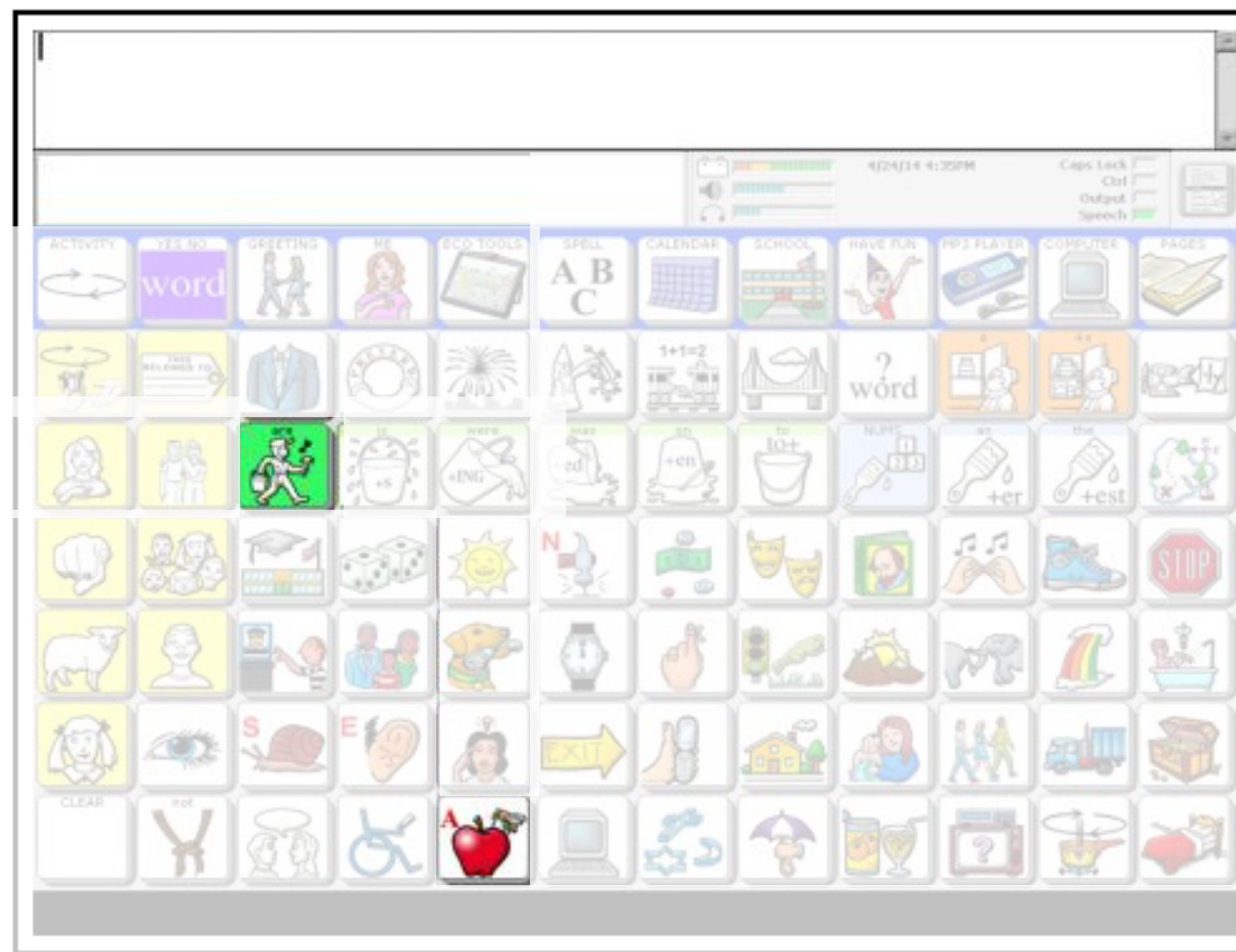
# Minspeak system



eat:



# Minspeak system



eat:



# Minspeak system



eat:  + 

apple:

# Minspeak system



eat:  + 

apple: 

# Minspeak system



eat:  + 

apple:  + 

# Minspeak system



eat:



+



apple:



+



# icon-based system structure

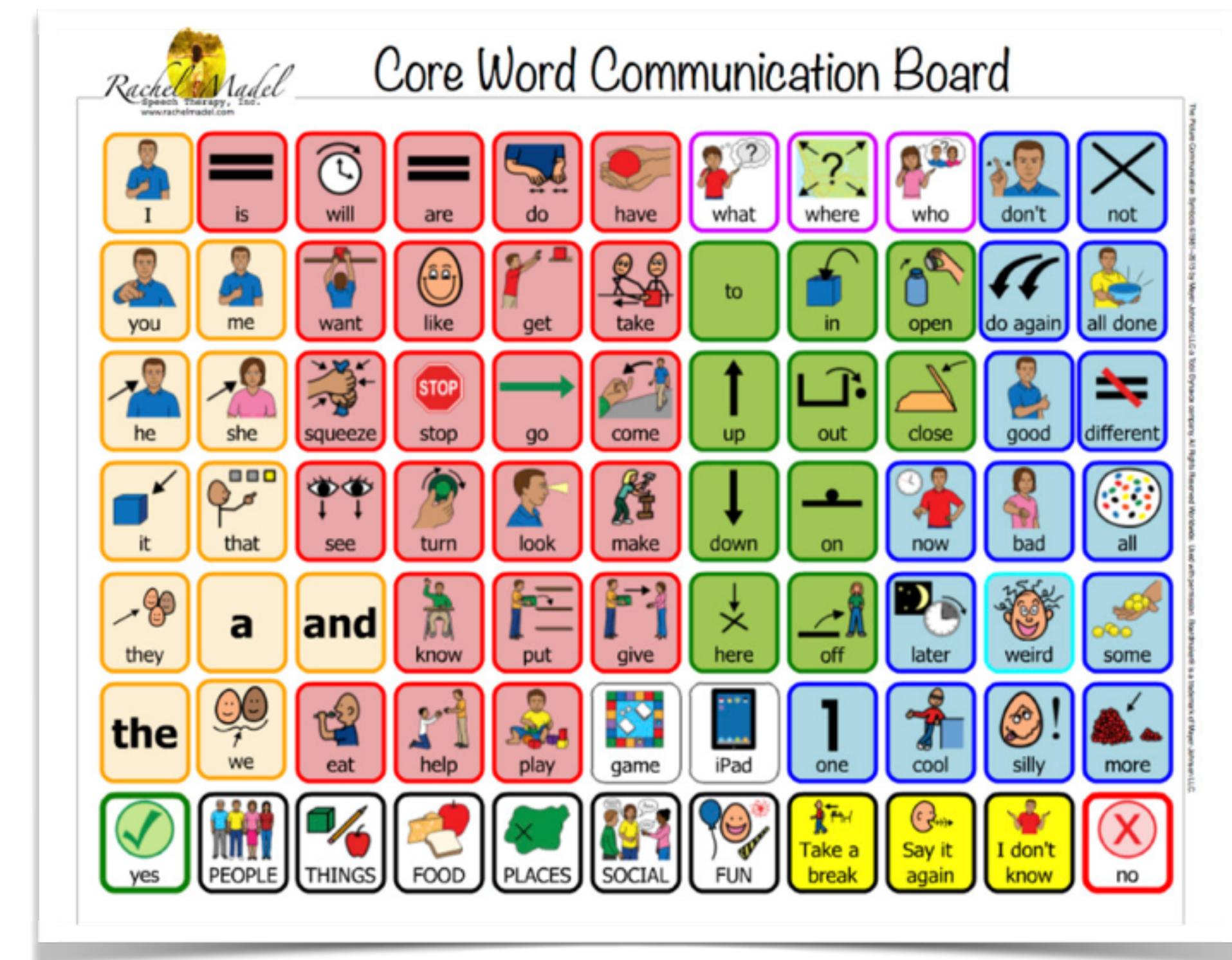
think bci

# cboard



Open-source communication board  
<https://www.cboard.io/cboard/open-source/2017/12/05/open-source-communication-board/>

# Core Board



electronic communication board  
<https://www.rachelmadel.com>

# Minspeak system



eat:



# Minspeak system



eat:  + 

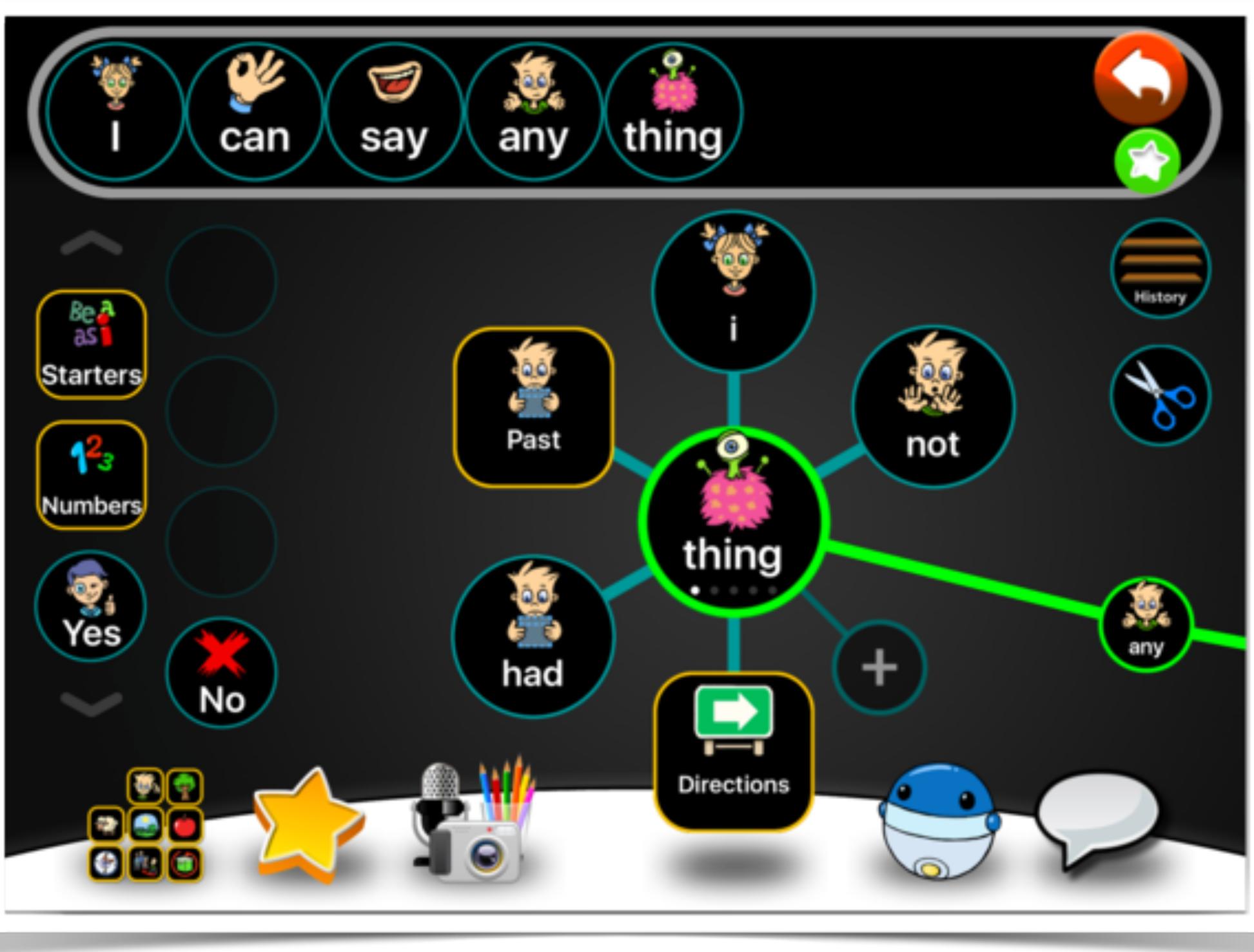
eat: RC  
eat: navigation

# AACorn



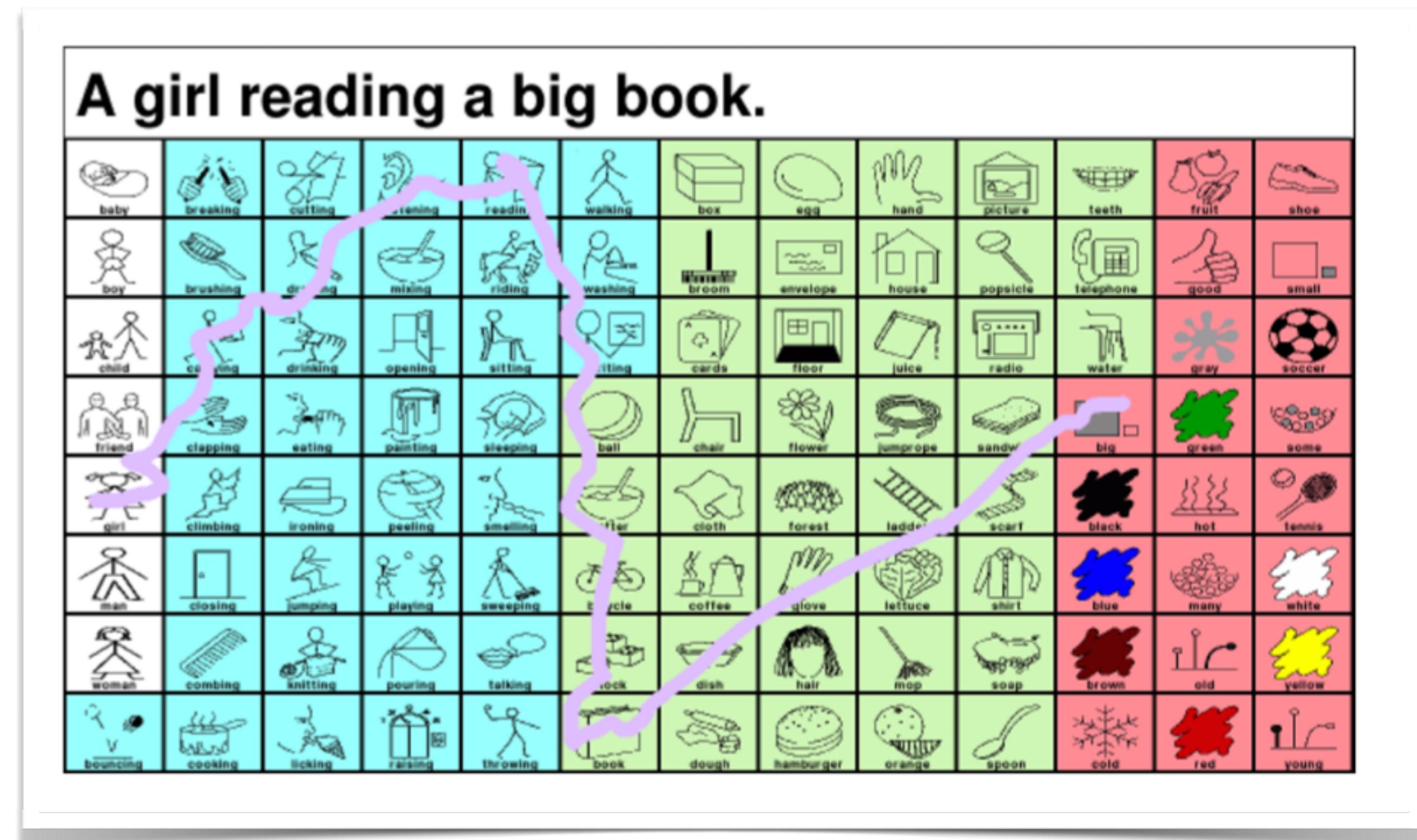
<http://www.aacornapp.com>

# AACorn



<http://www.aacornapp.com>

# SymbolPath



Karl Wiegand et al, SymbolPath:  
A Continuous Motion Overlay Module for Icon-Based Assistive Communication, 2012b

Scaling?

Selection modality

Scaling?

Selection modality

Finally, we transition to present our current research

Our goal:

Creating an icon language-model based AAC system



# RSVPKeyboard



# Symbolstix Icon set

# Symbolstix Icon set

Used by communities who are in need of icon-based communication

# Symbolstix Icon set

Used by communities who are in need of icon-based communication

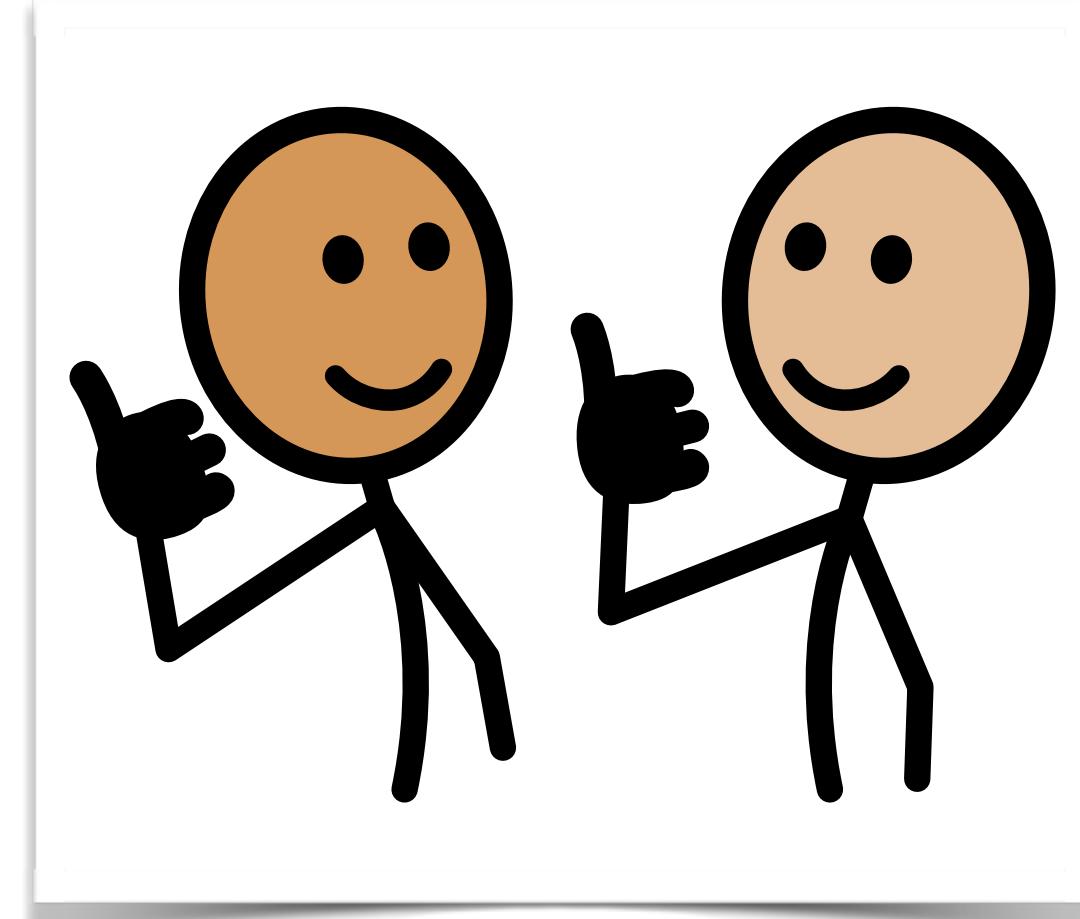
Human Curated icons

# Symbolstix Icon set

Used by communities who are in need of icon-based communication

Human Curated icons

5,101 single words, 3,545 unique single words



name: agree

word type: verb

synonyms: agreement

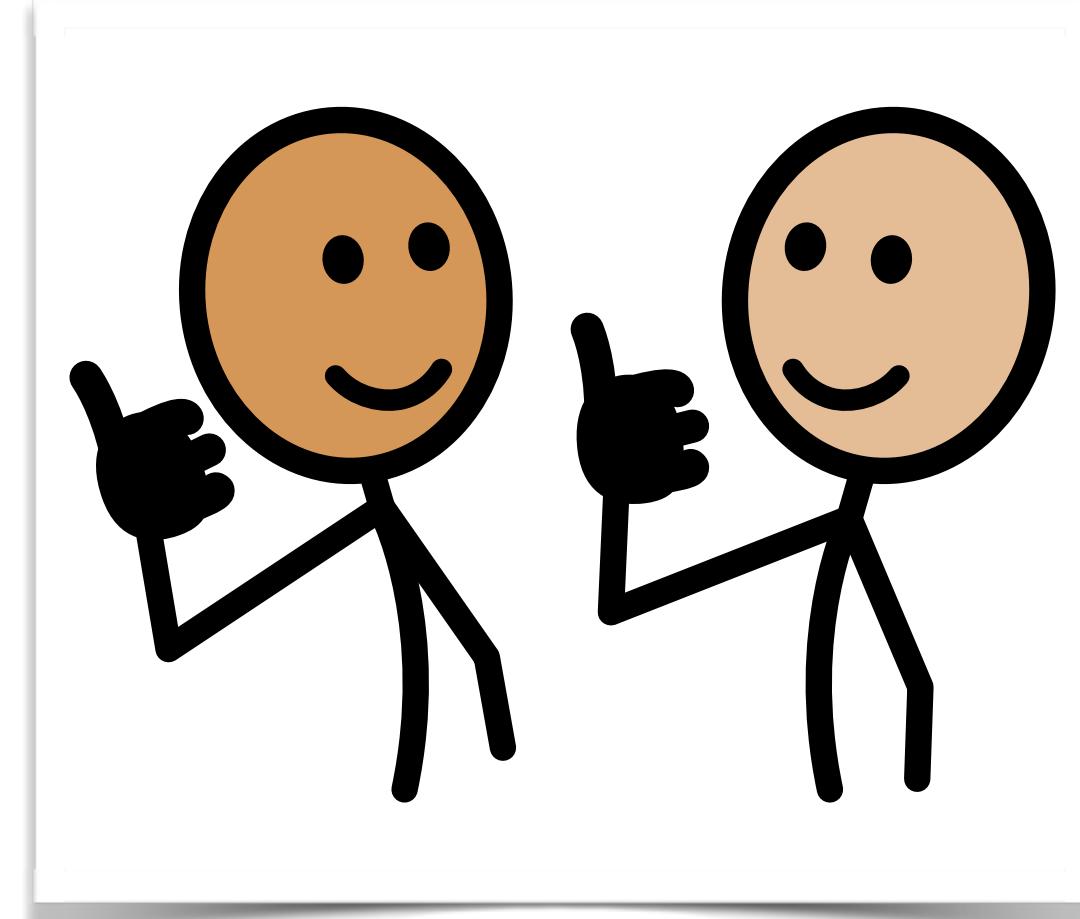
agreed      agrees

agreeing      approve

flexibility      concur

on the same page

see eye to eye



name: agree

word type: verb

synonyms: agreement

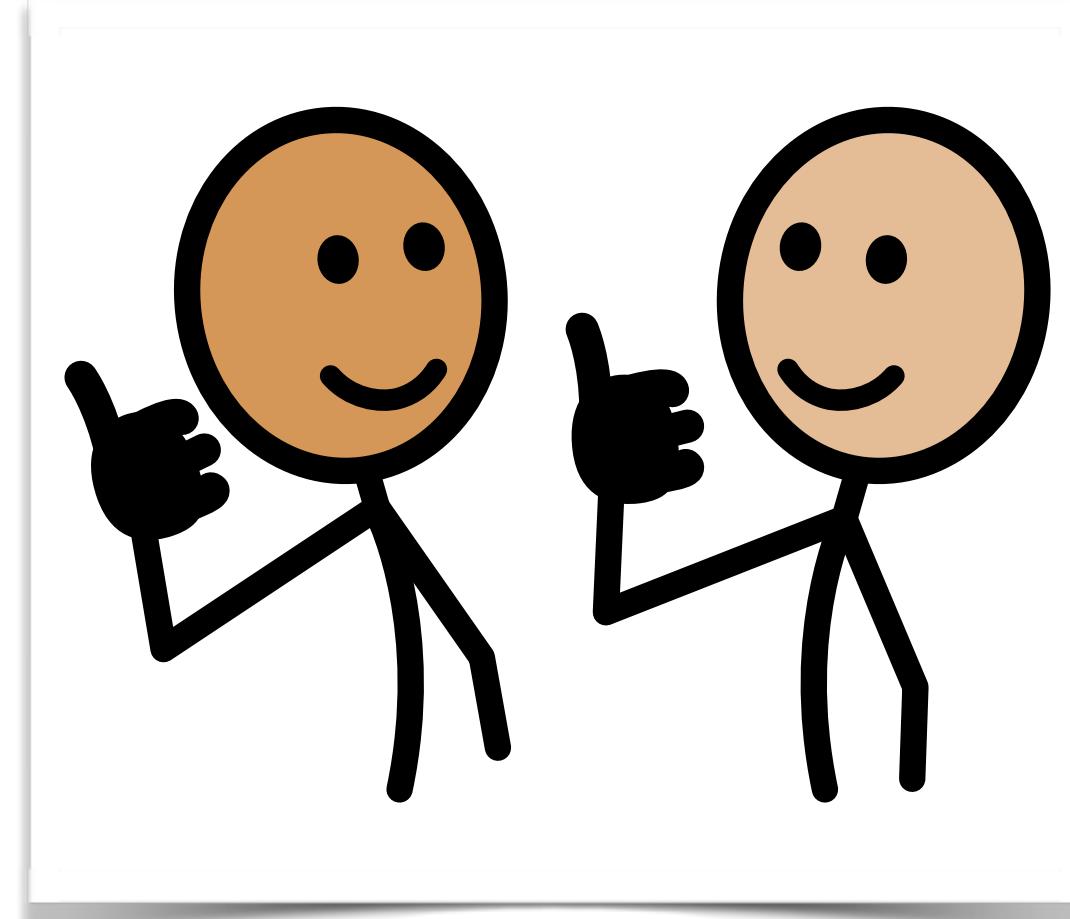
agreed      agrees

agreeing      approve

flexibility      concur

on the same page

see eye to eye



name: agree

word type: verb

synonyms: agreement

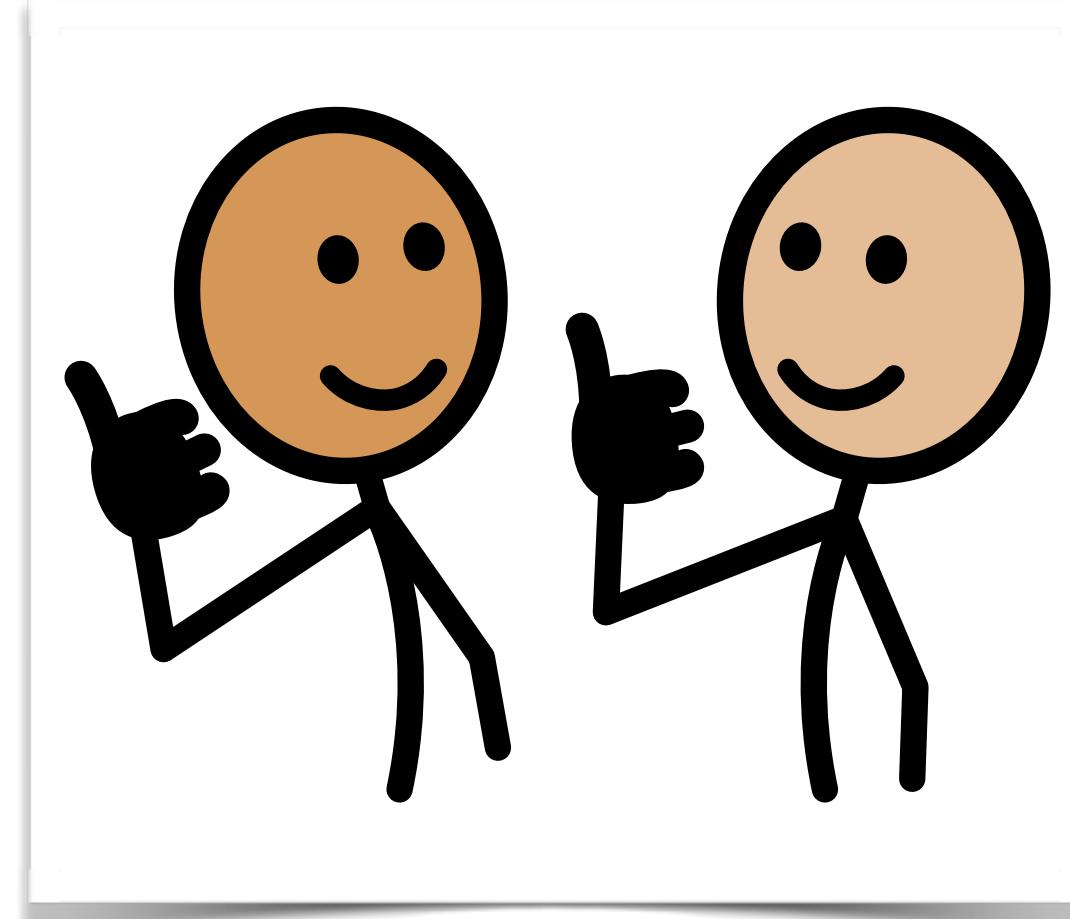
agreed      agrees

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on the same page

see eye to eye



name: agree

word type: verb

synonyms: agreement

agreed      agrees

agreeing      approve

flexibility      concur

on the same page

see eye to eye

# Symbolstix Icon set

Used by communities who are in need of icon-based communication

Human Curated icons

5,101 single words, 3,545 unique single words

# Symbolstix Icon set

Used by communities who are in need of icon-based communication

Human Curated icons

5,101 single words, 3,545 unique single words

No Corpus available!

## Our Question:

How to create language models for corpus-less  
symbol-set

We don't have:

We don't have:

icon corpus

We don't have:

~~icon corpus~~

We don't have:

~~icon corpus~~

we have:

- - -

We don't have:

~~icon corpus~~

we have:

- Icon meta-data

—  
—  
—

We don't have:

~~icon corpus~~

we have:

- Icon meta-data
- pre existing textual corpora

—

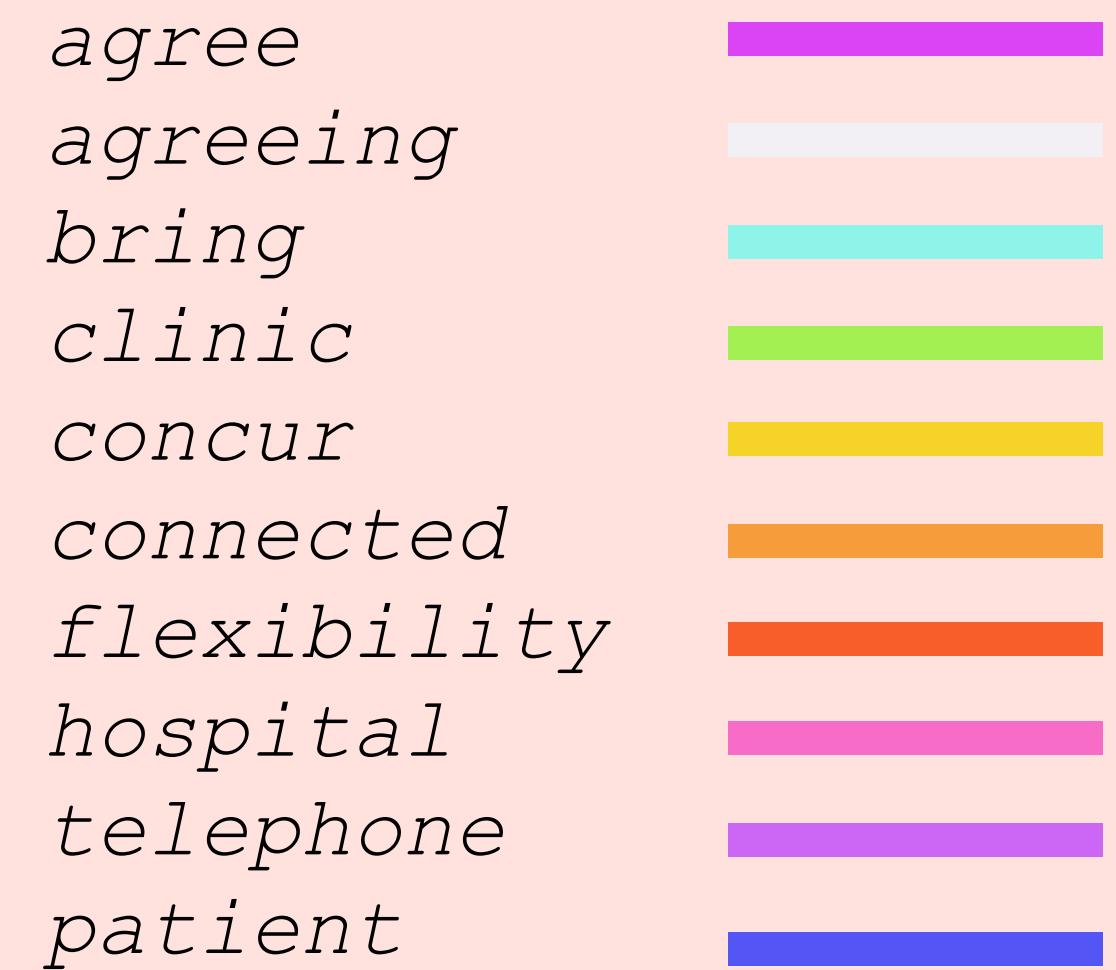
We don't have:

~~icon corpus~~

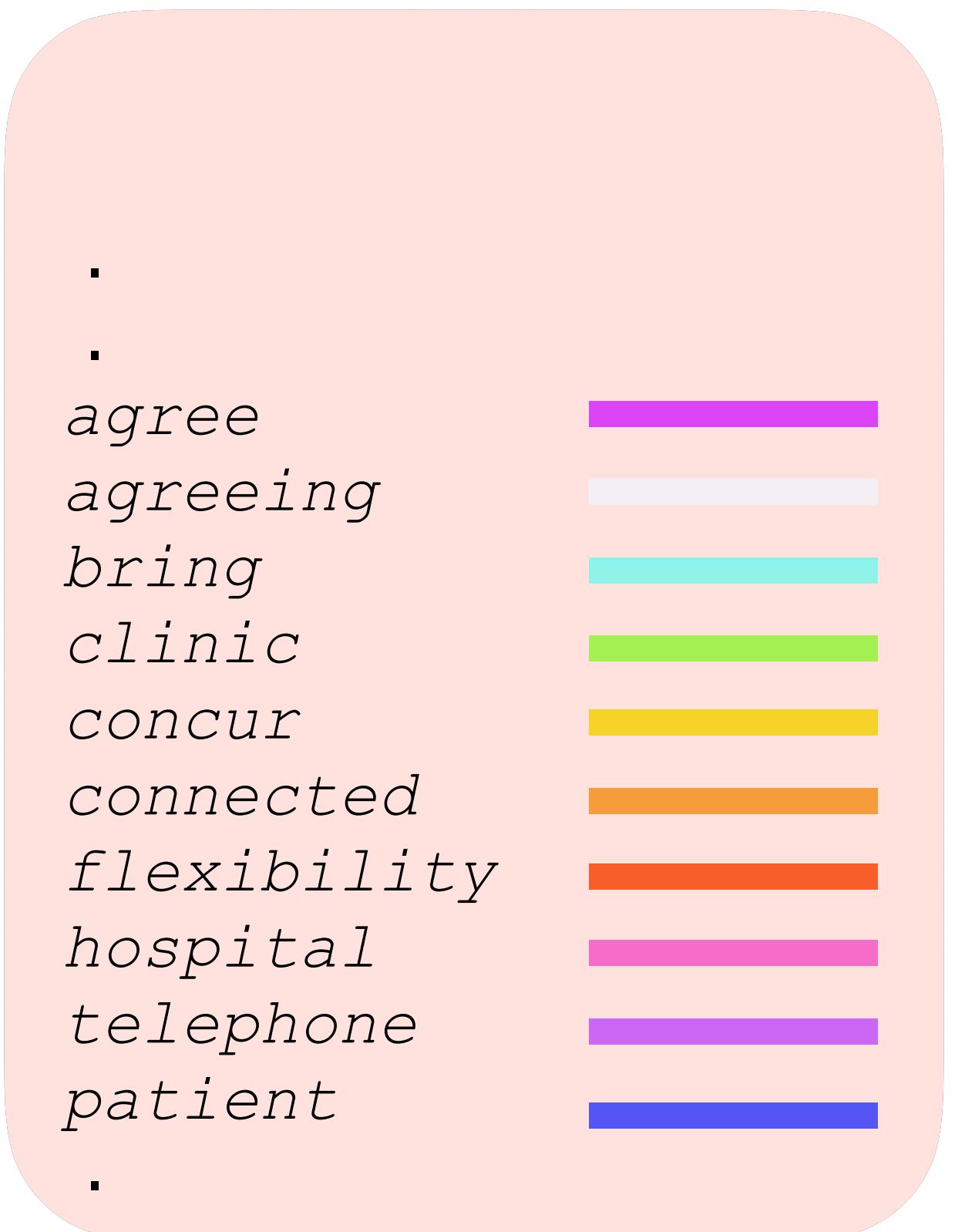
we have:

- Icon meta-data
- pre existing textual corpora
- Word embedding representation

—



telephone



concur

agree

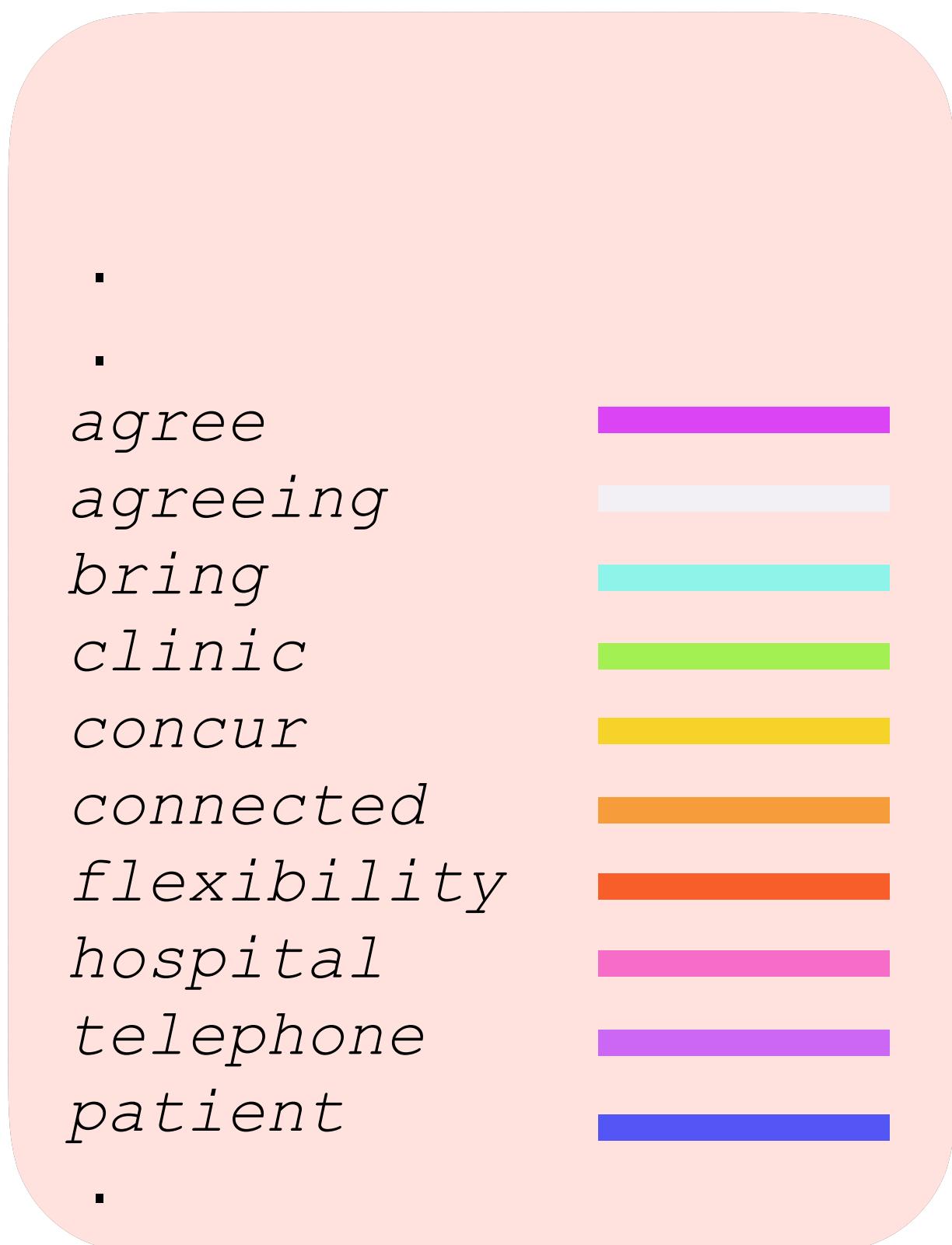
agreeing

patient

clinic

hospital

telephone



concur

agree

agreeing

patient

clinic

hospital

We don't have:

~~icon corpus~~

we have:

- Icon meta-data
- pre existing textual corpora
- Word embedding representation

—

We don't have:

~~icon corpus~~

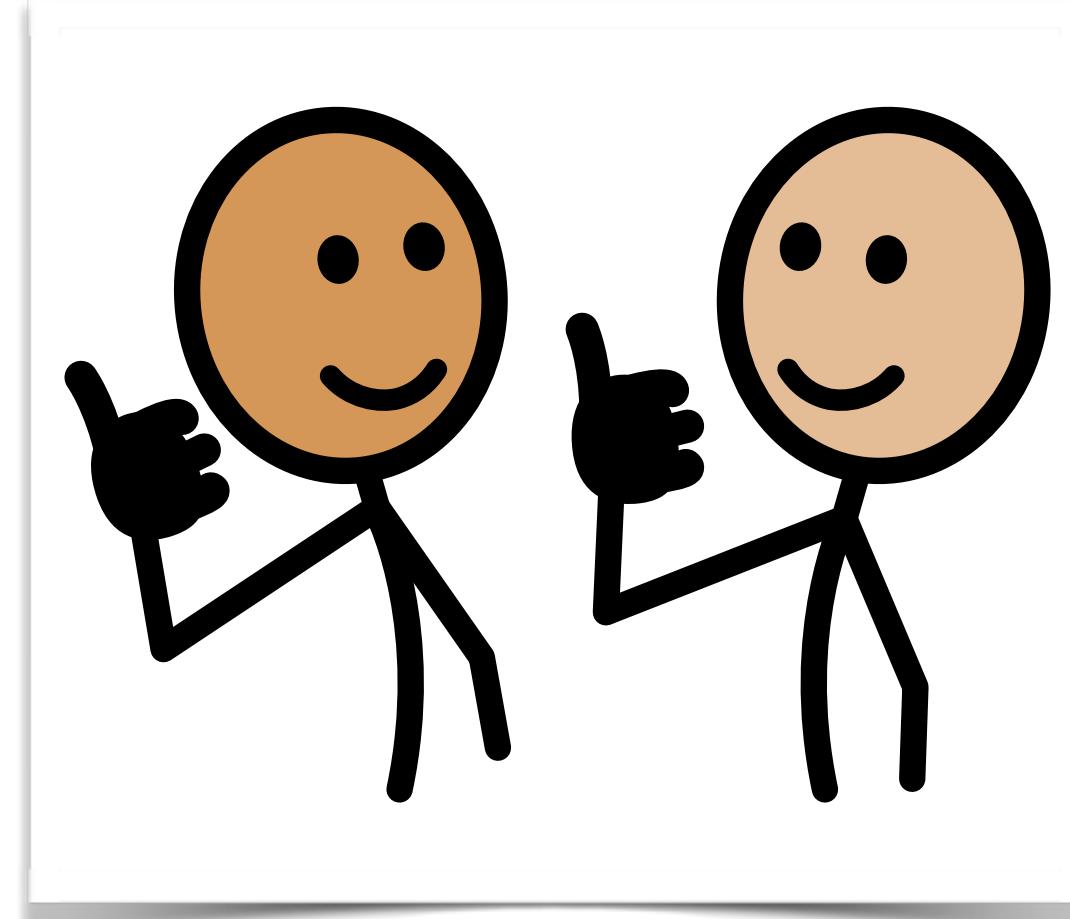
we have:

- Icon meta-data
- pre existing textual corpora
- Word embedding representation

Perhaps we can utilize the synonyms, apply to textual corpus?



## *Icon representation*



name: agree

word type: verb

synonyms: agreement

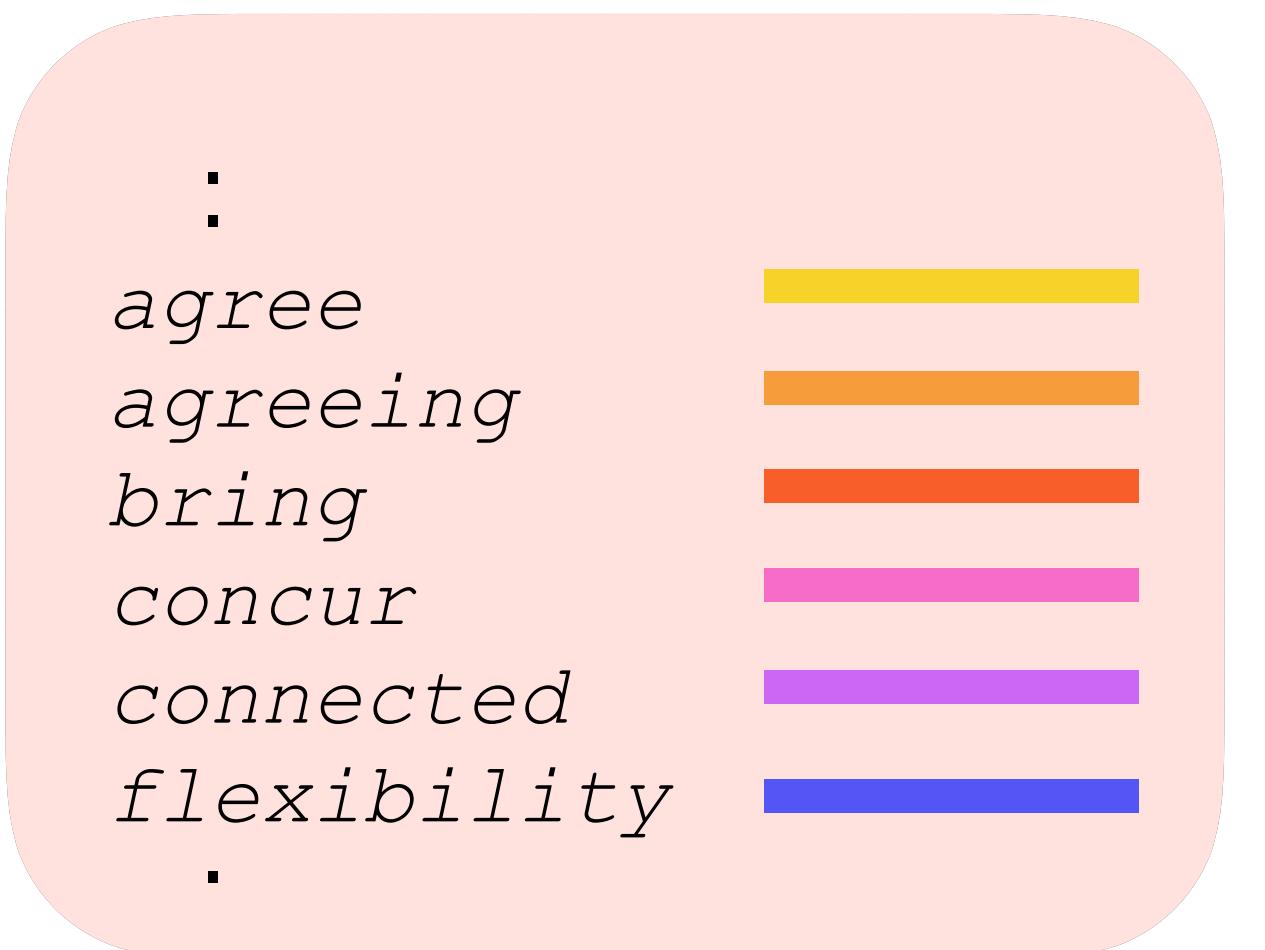
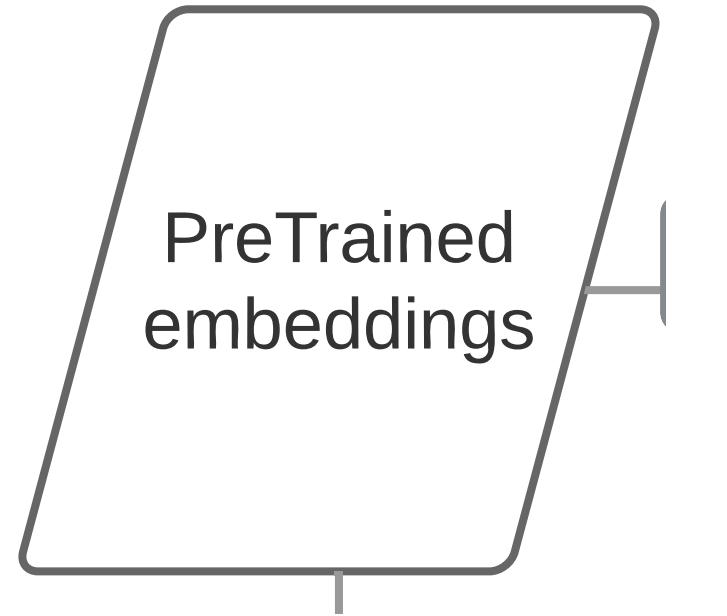
agreed      agrees

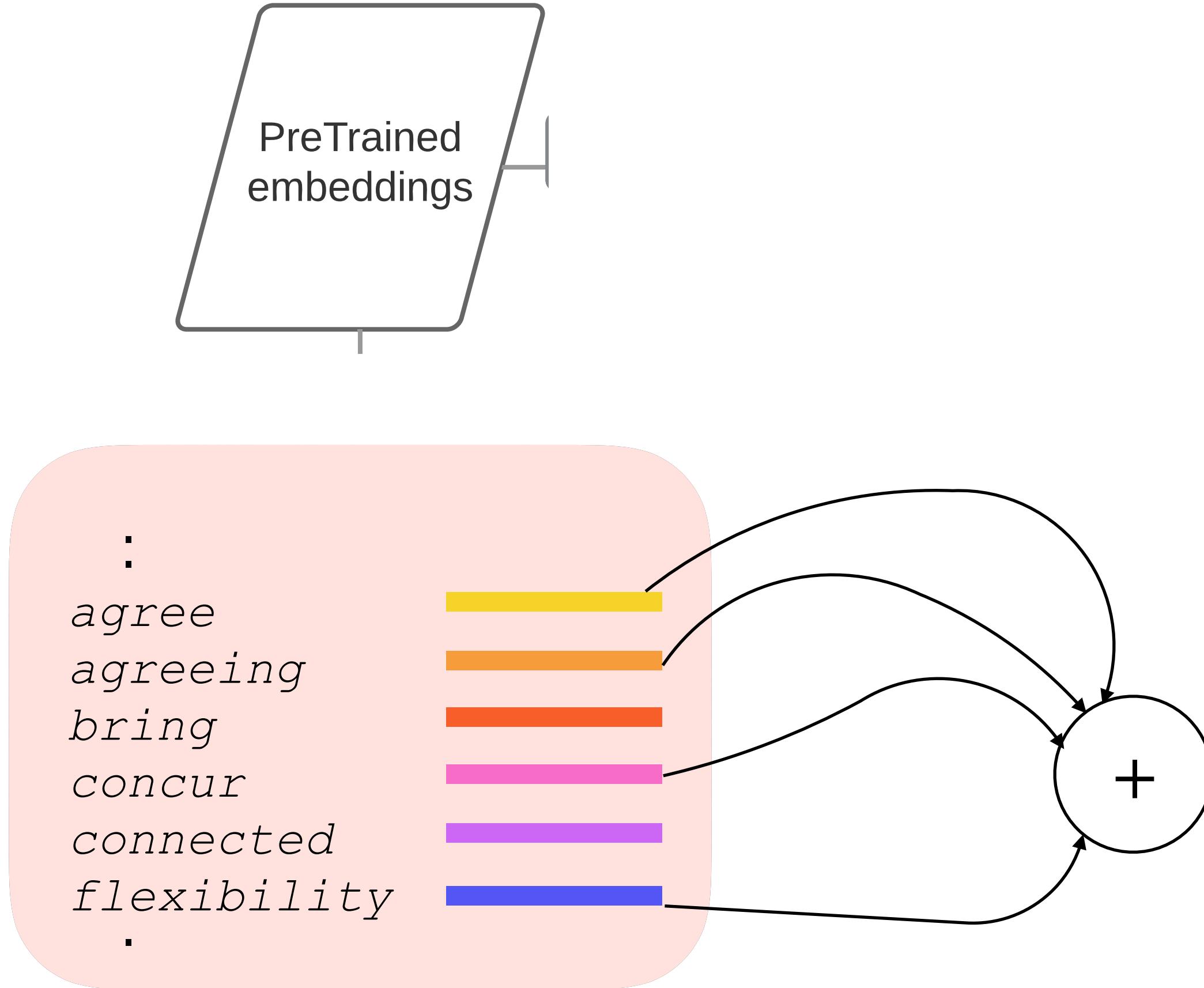
agreeing      approve

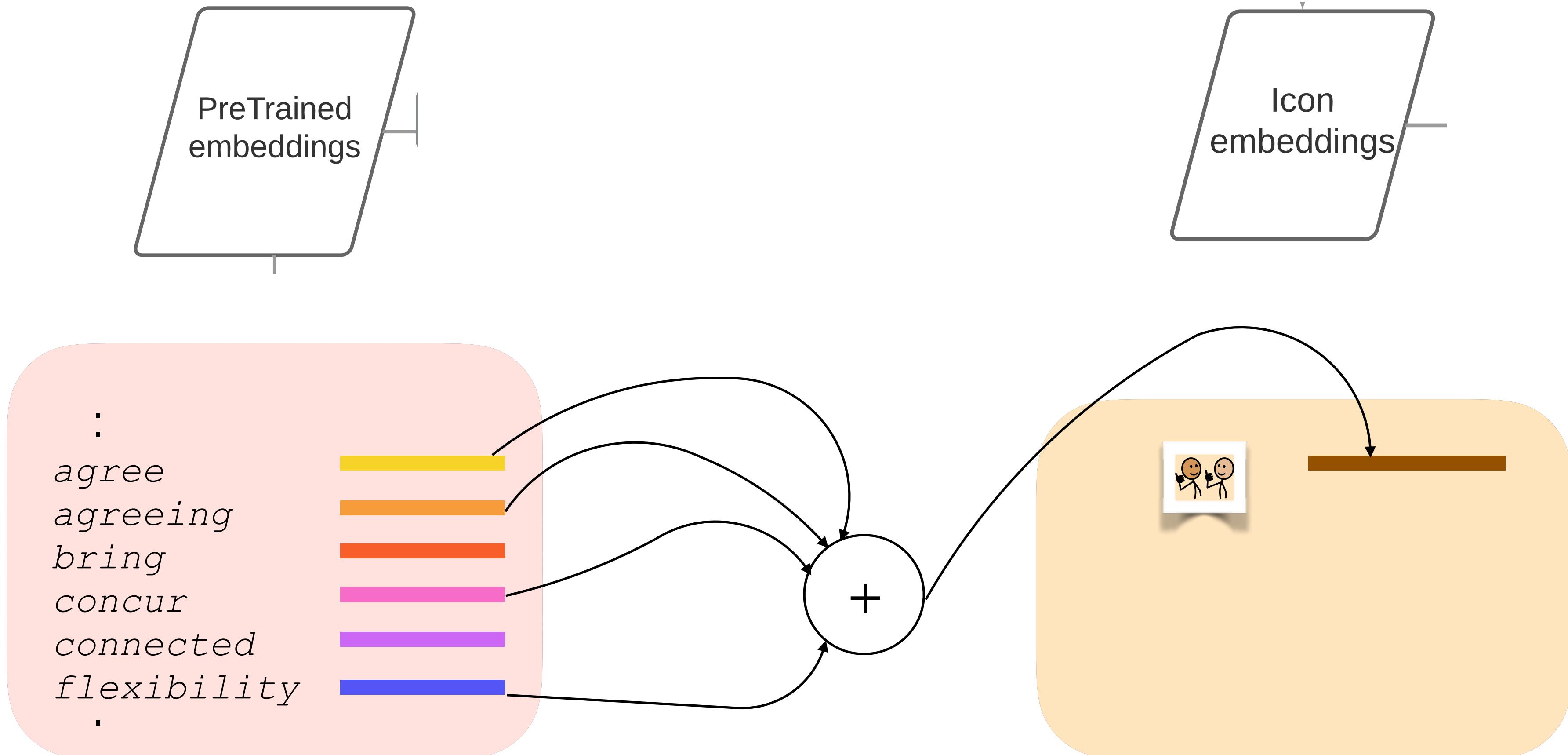
flexibility      concur

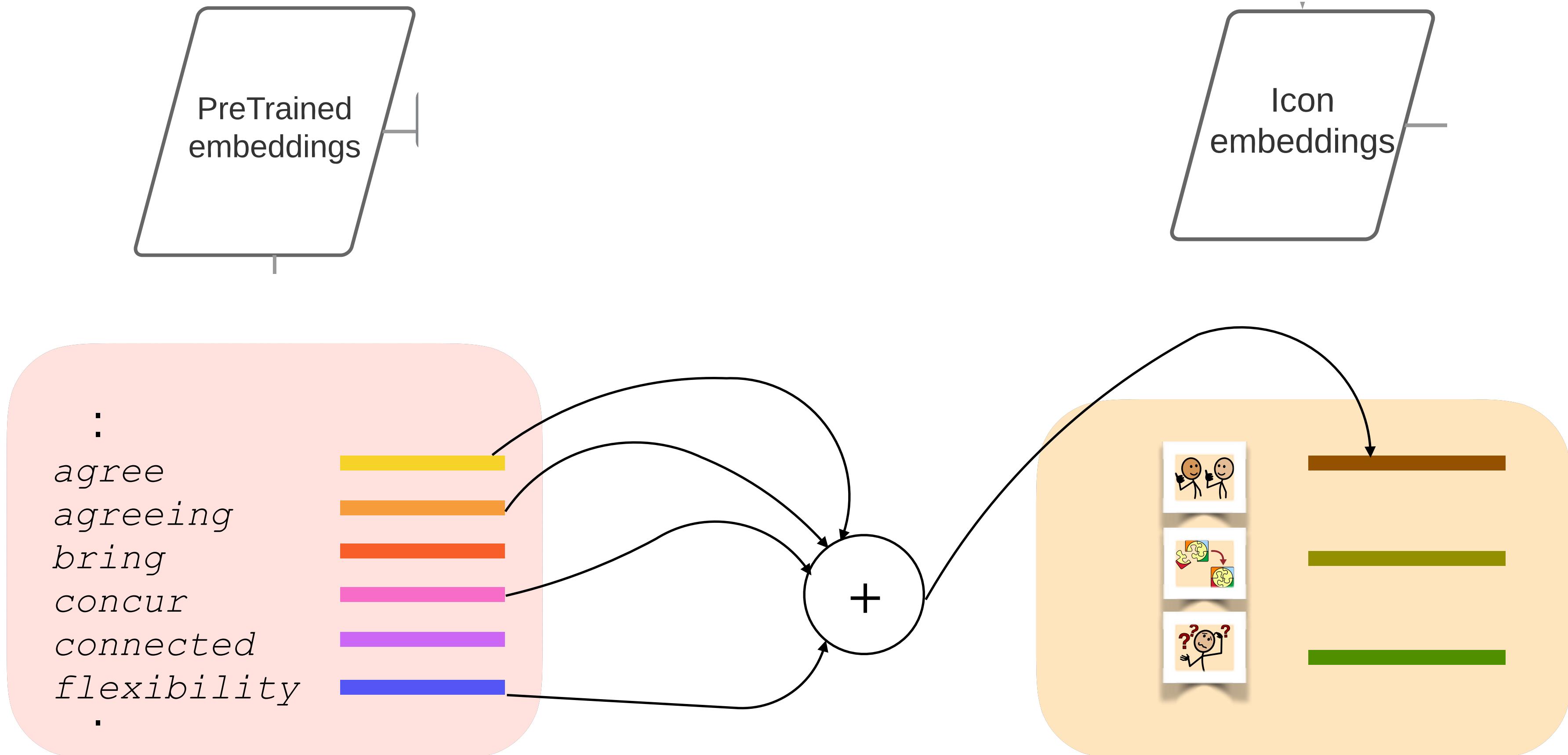
on the same page

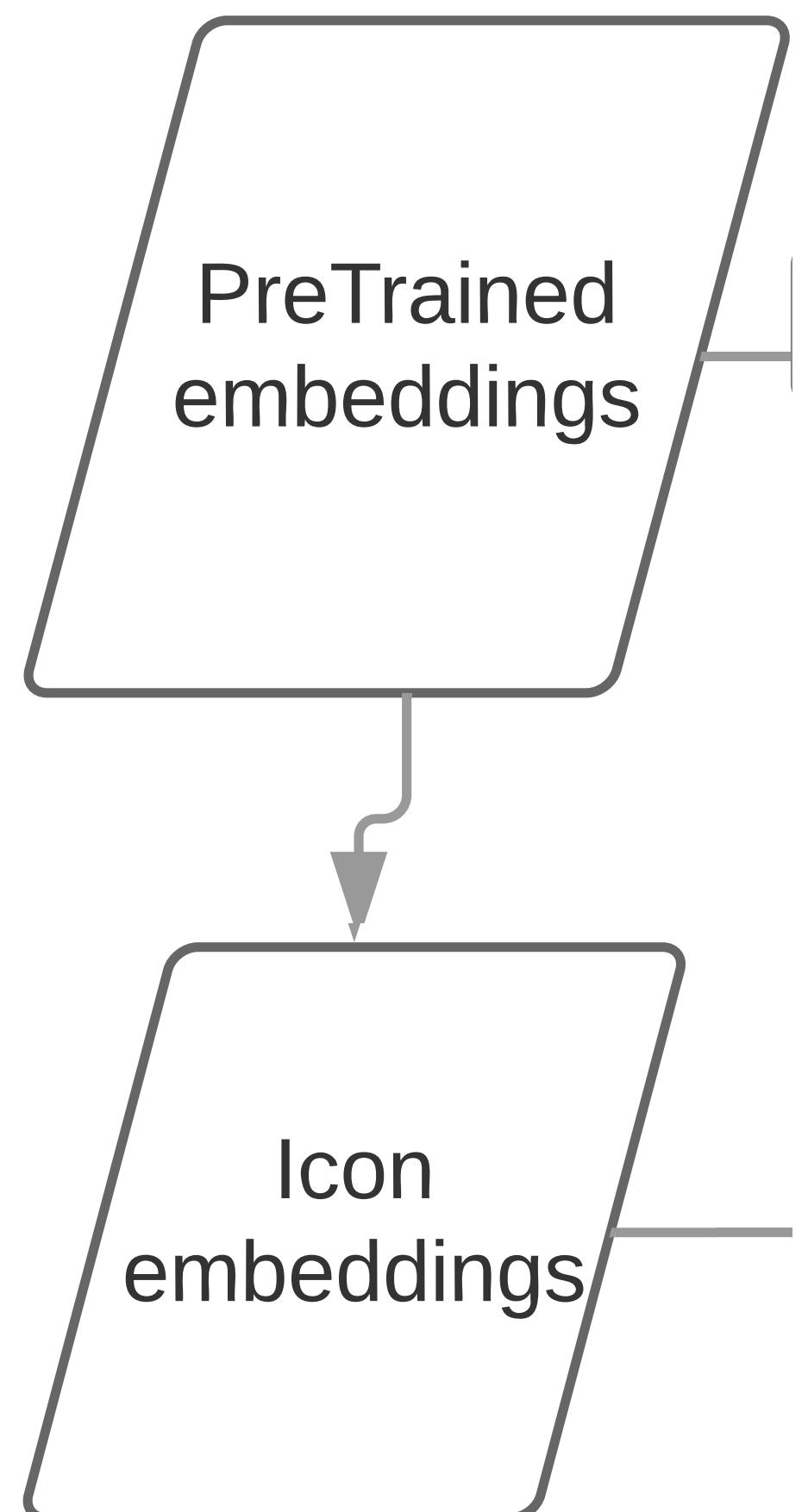
see eye to eye

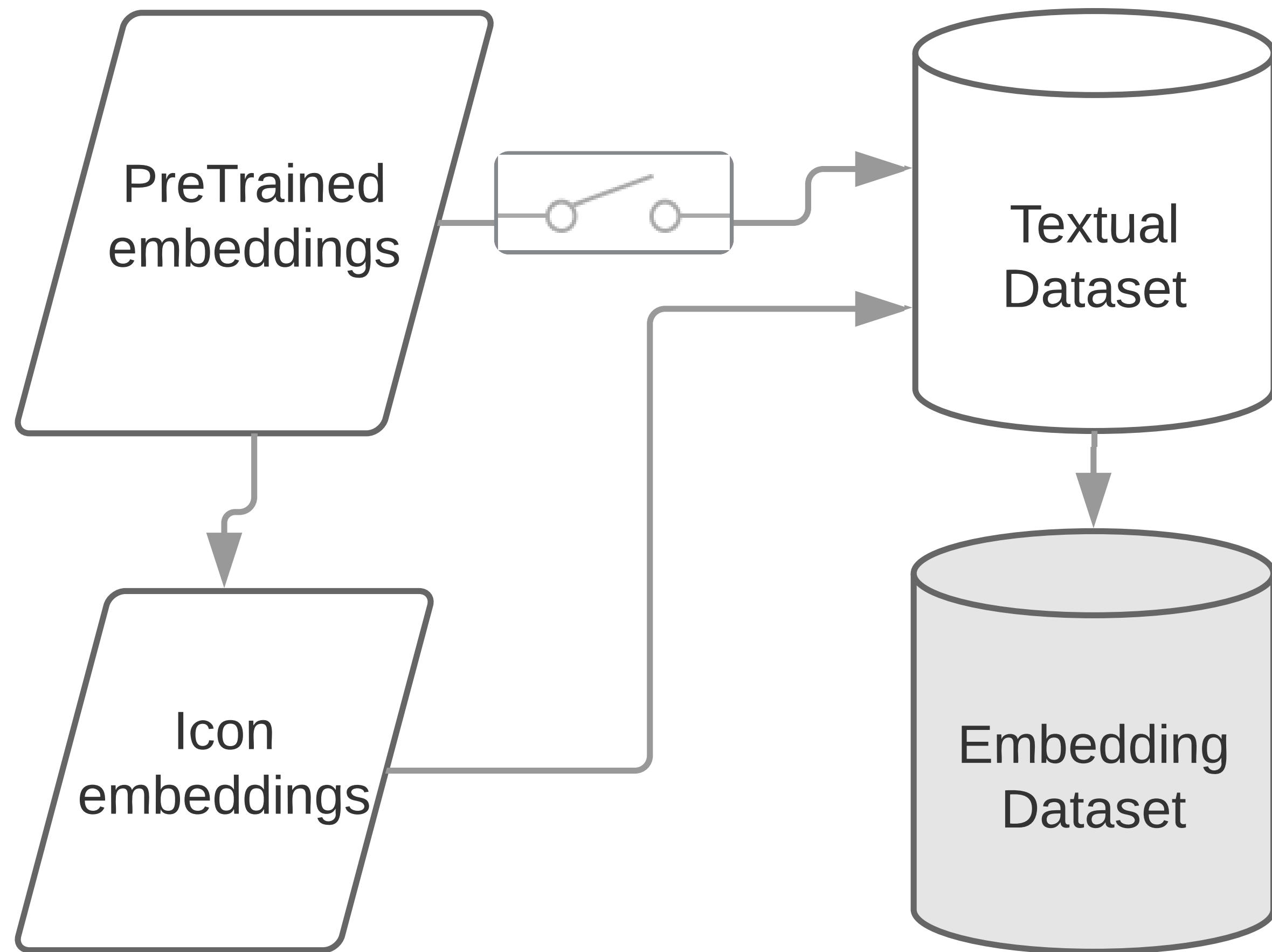


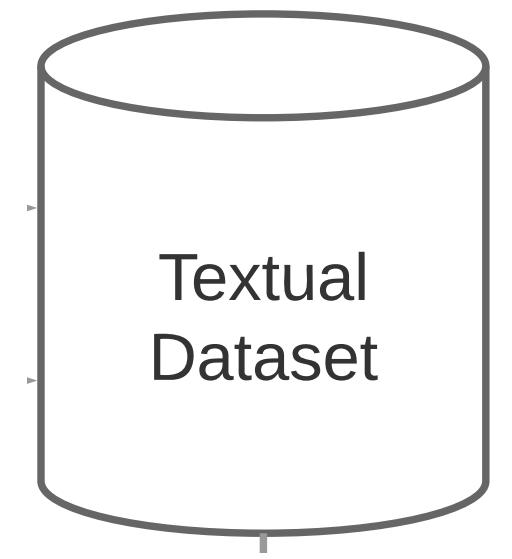




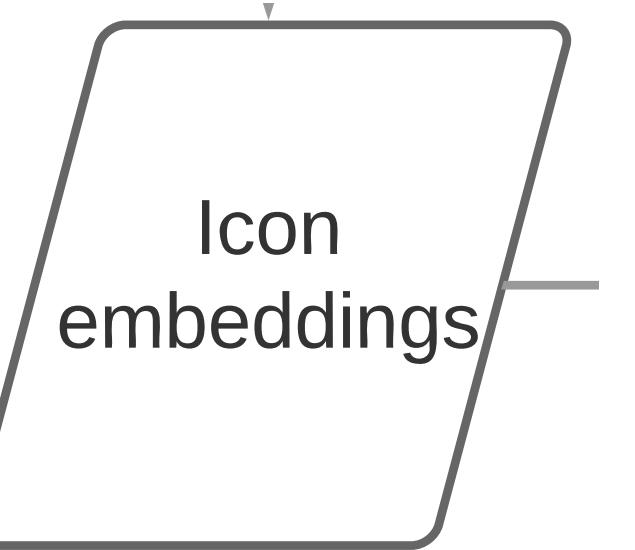




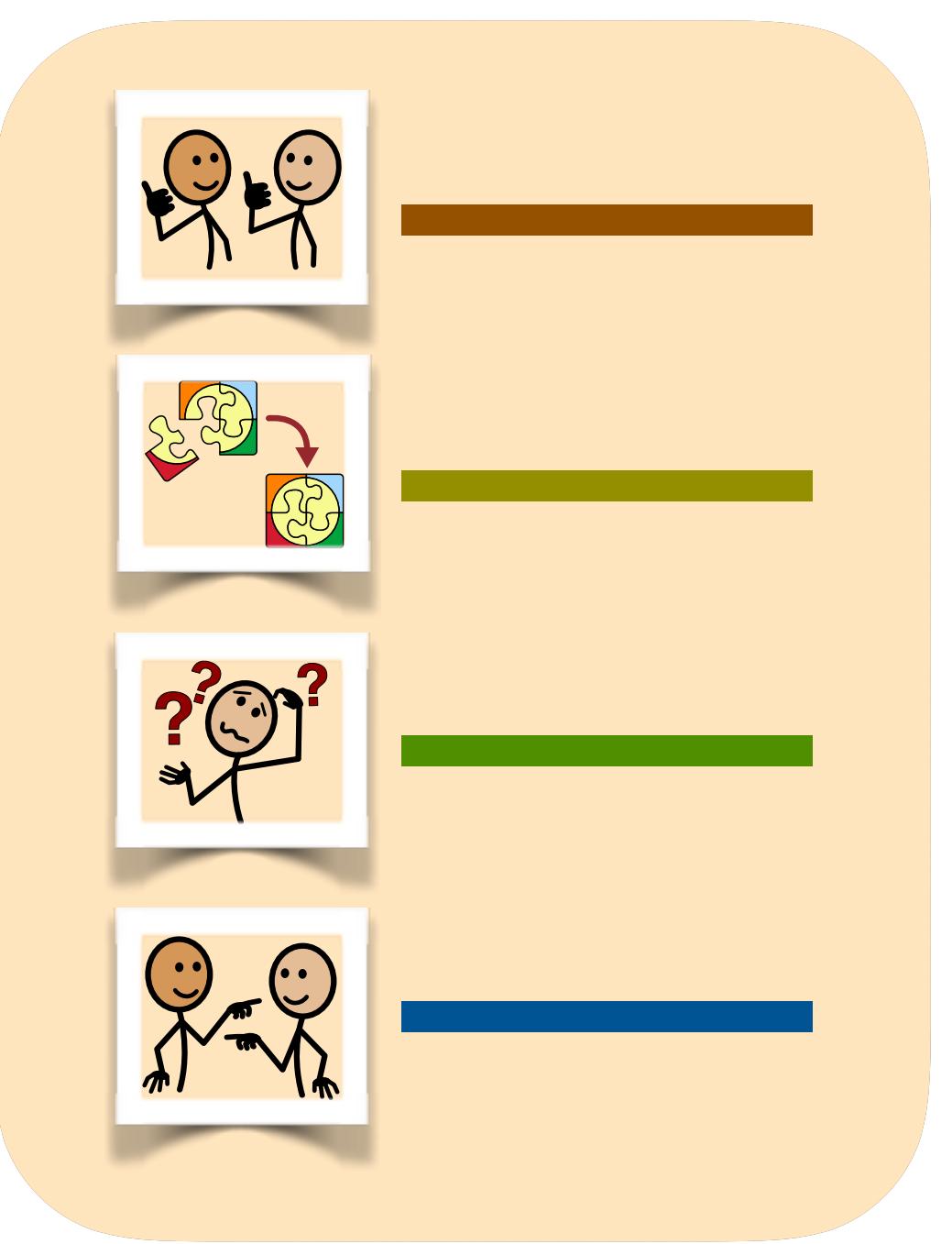


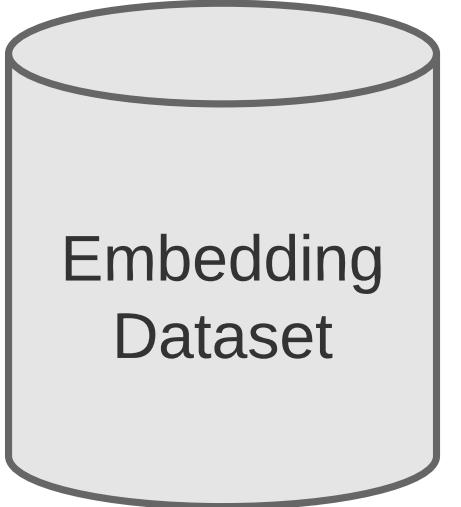
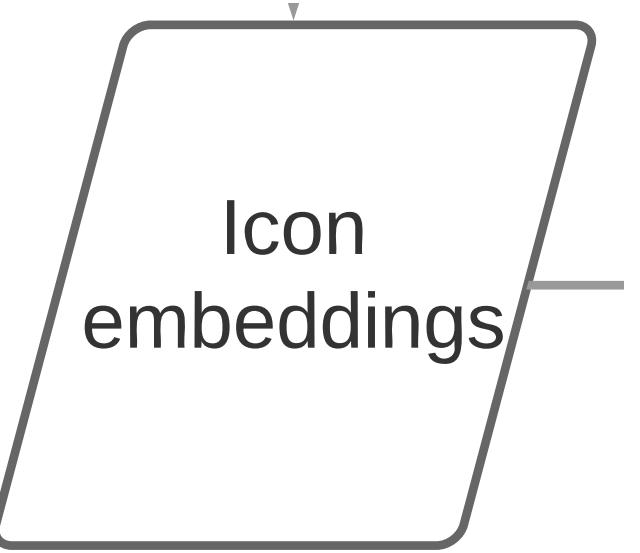


... you agree to solve  
problems ...

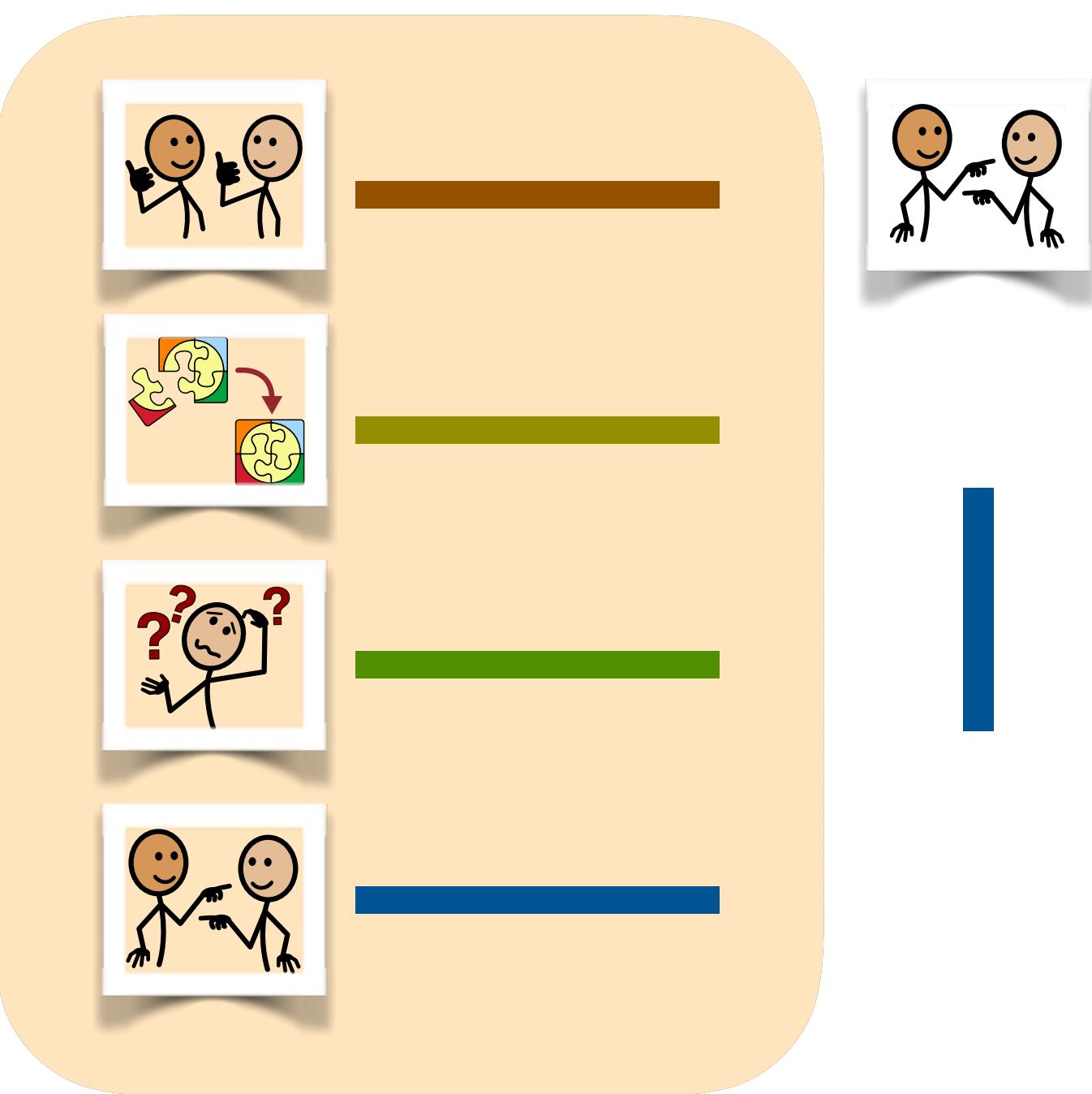


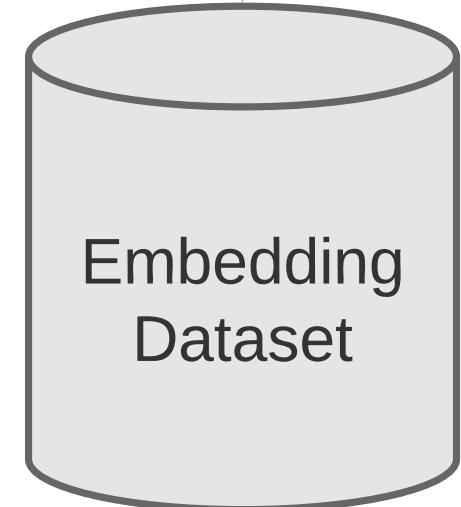
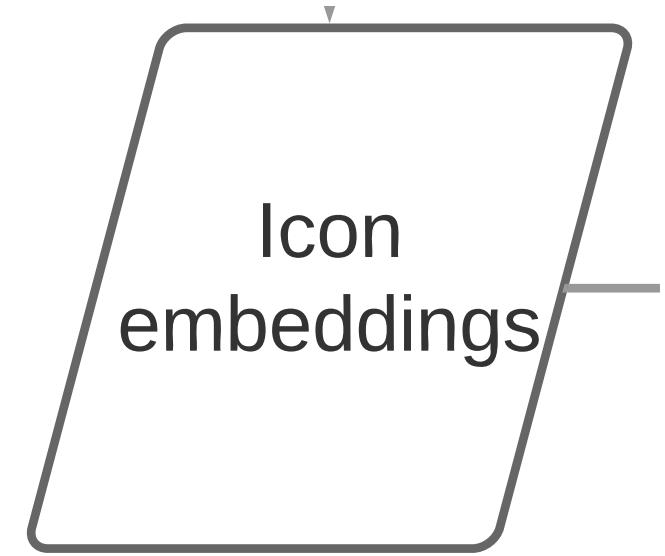
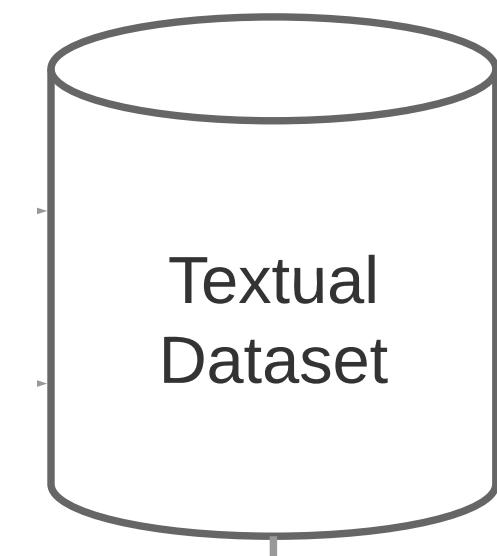
... you agree to solve  
problems ...



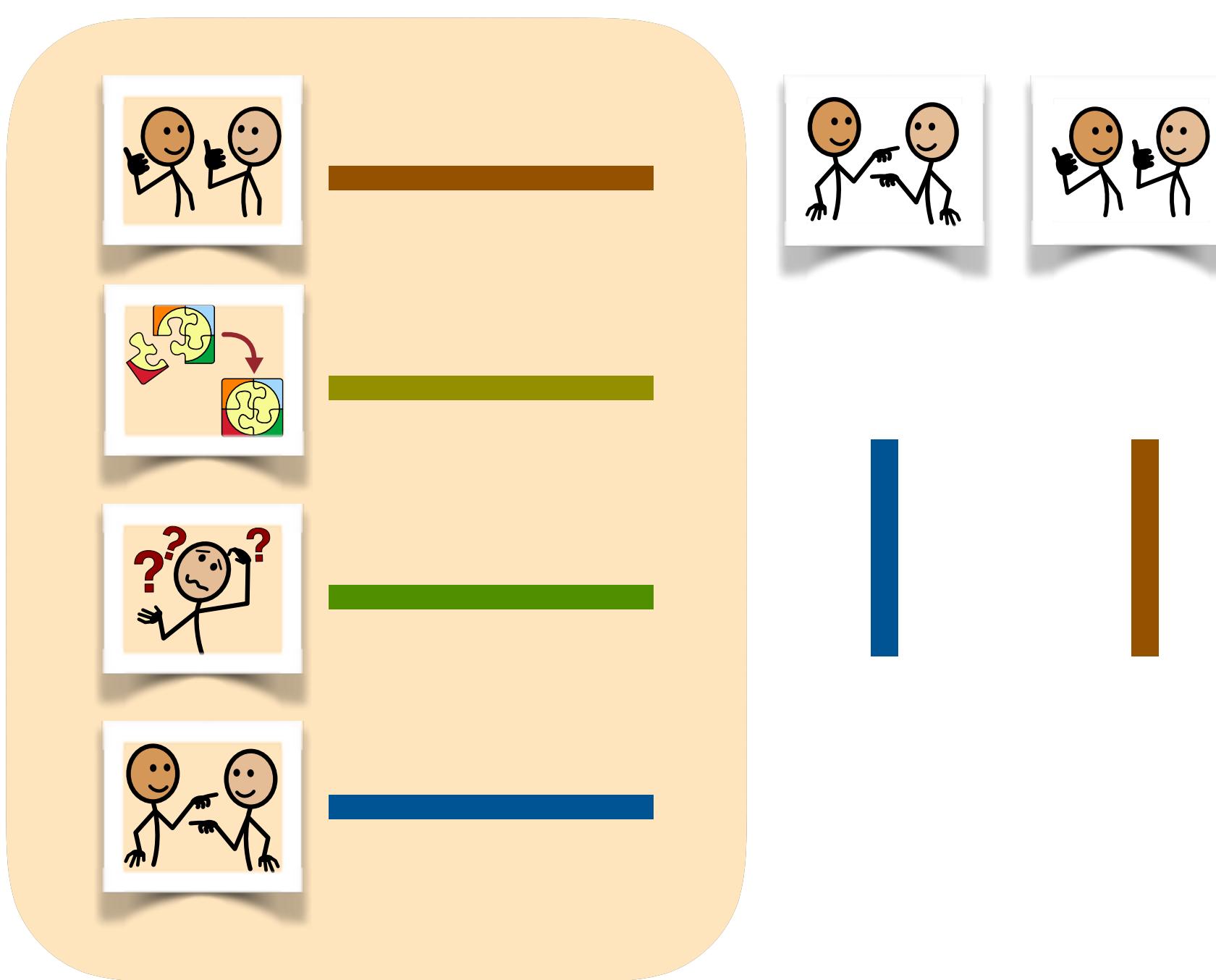


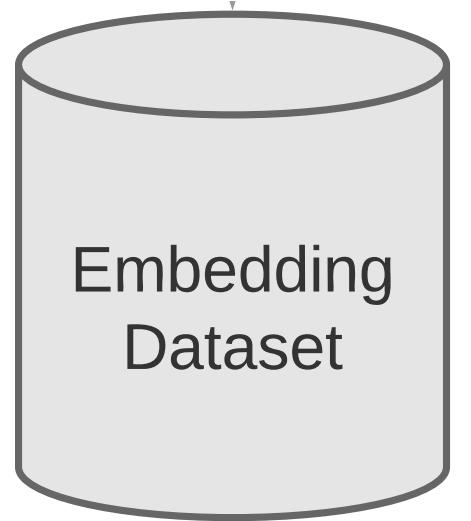
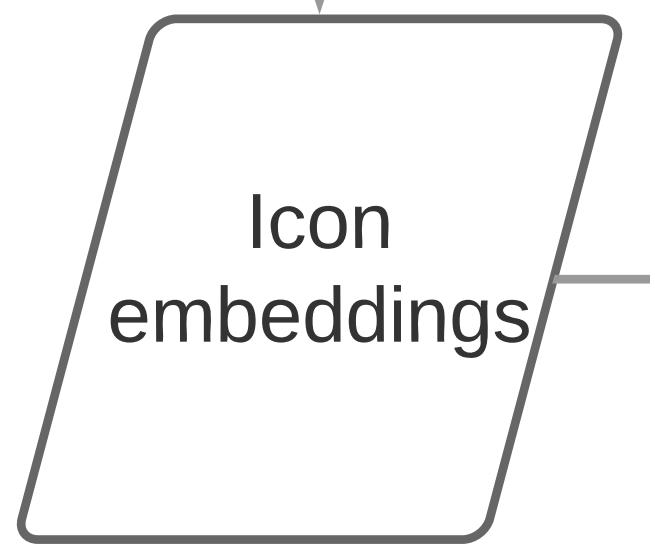
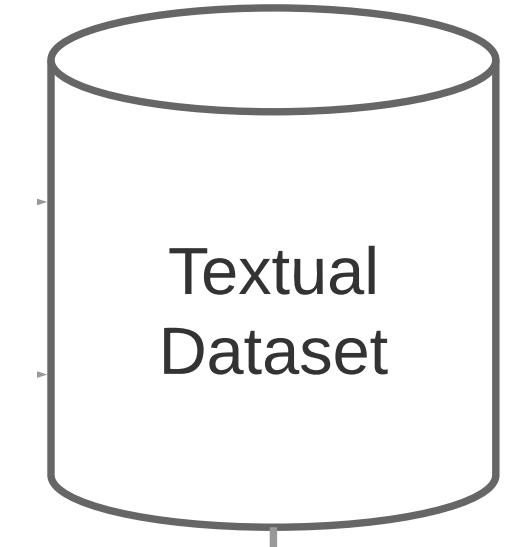
... **you** agree to solve  
problems ...



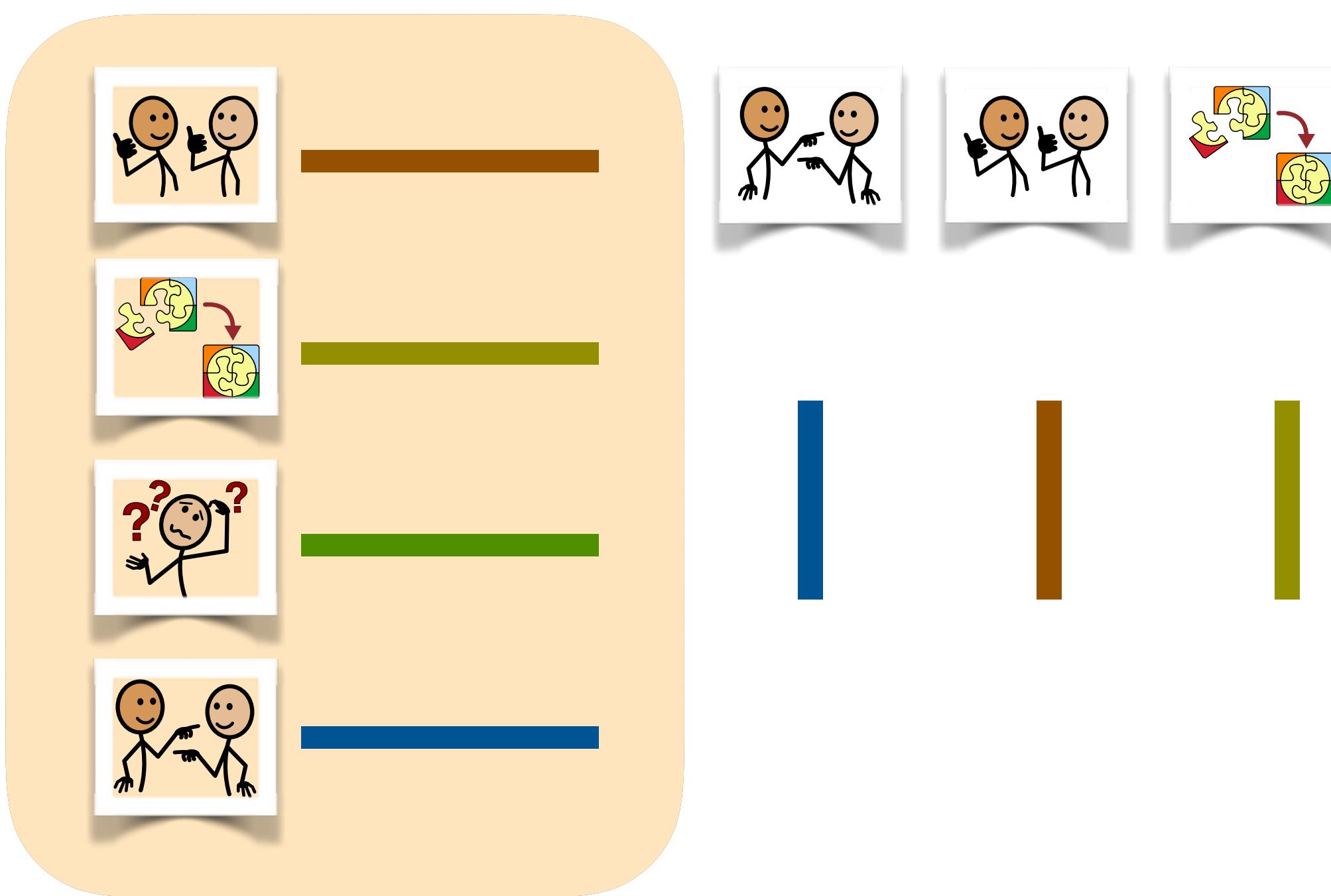


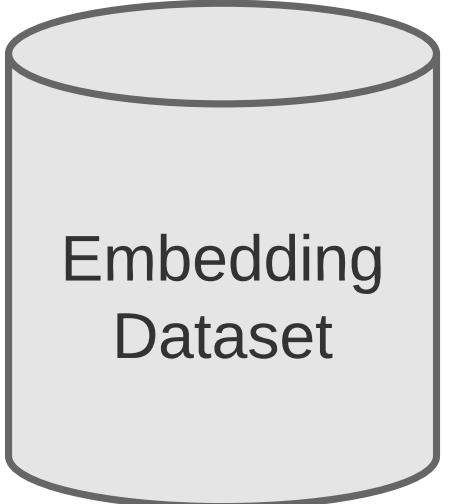
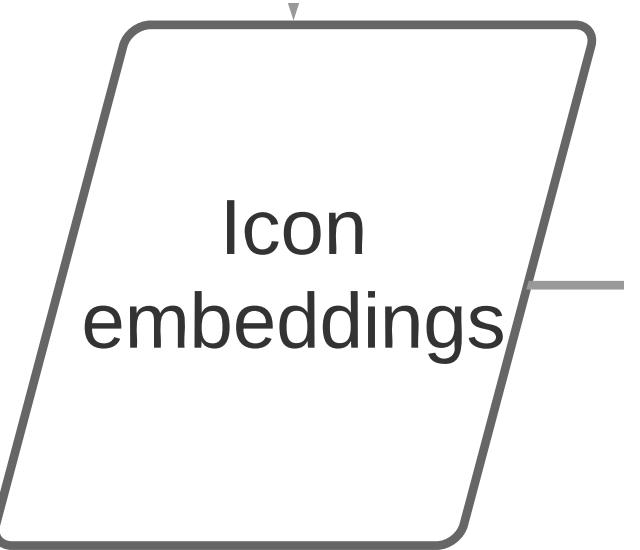
... you **agree** to solve  
problems ...



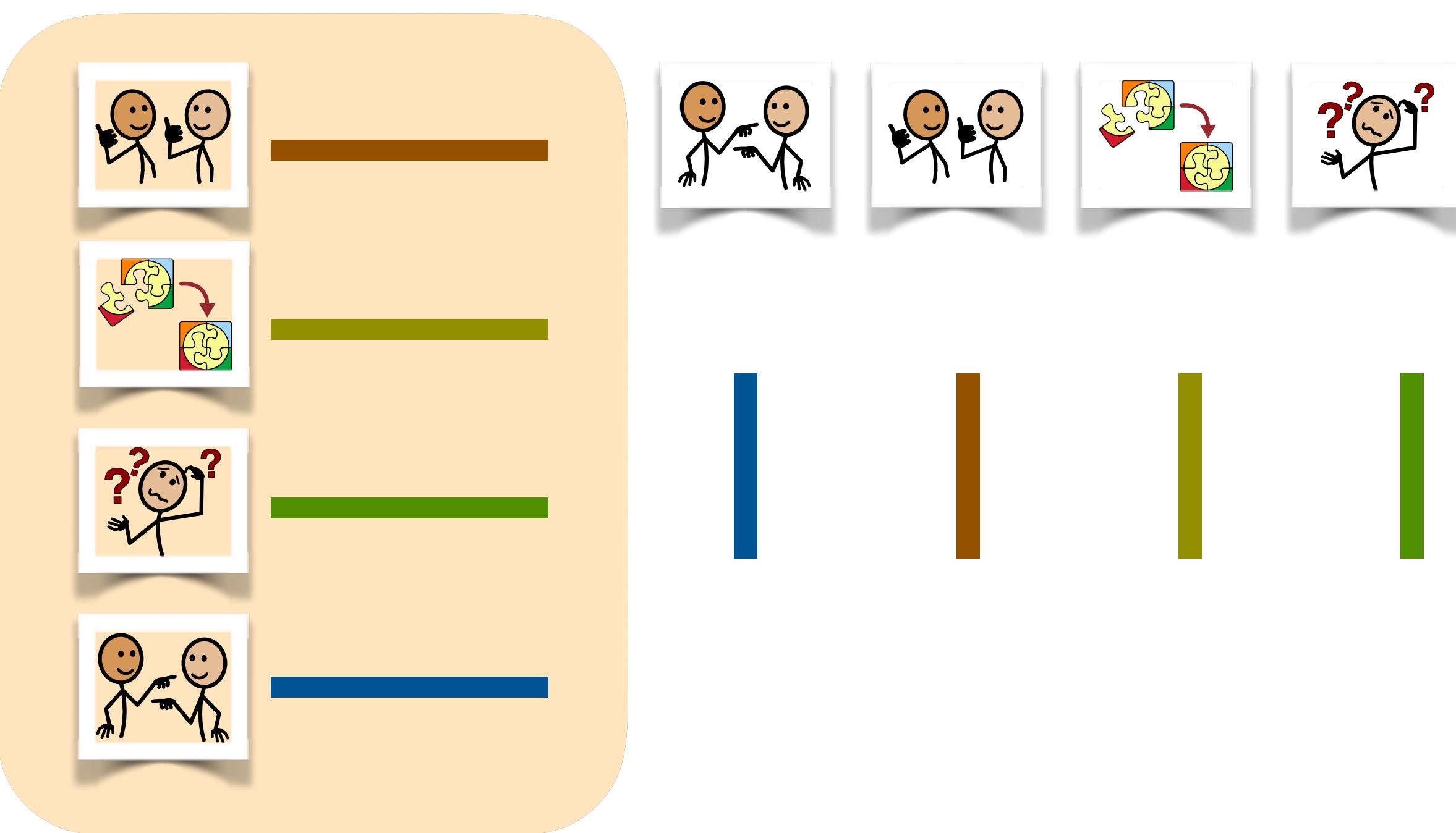


... you agree to **solve**  
problems ...





... you agree to solve  
**problems** ...



Ideally our icon language would form the following messages:

a message:

a message:

<i> <go> <here><m:past>

a message:

<i> <go> <here><m:past>

English:

<i> <went> <here>

a message:

<i> <go> <here><m:past>

English:

<i> <went> <here>

icon:

<i> <go> <here> <past>

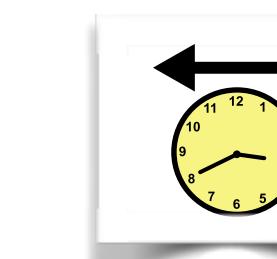
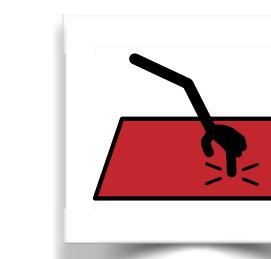
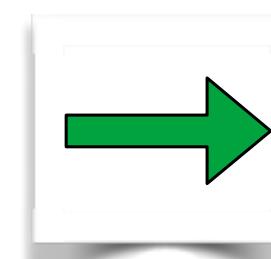
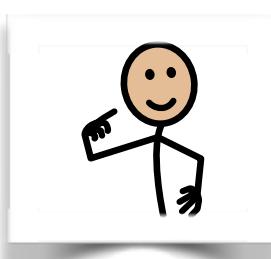
a message:

<i> <go> <here><m:past>

English:

<i> <went> <here>

icon:



<i> <go> <here> <past>

a message:

a message:

<these> <dog> <m:plural> <at> <home>

a message:

<these> <dog> <m:plural> <at> <home>

English:

<these> <dogs> <are> <at> <home>

a message:

<these> <dog> <m:plural> <at> <home>

English:

<these> <dogs> <are> <at> <home>

icon:

<these> <dog> <plural> <at> <home>

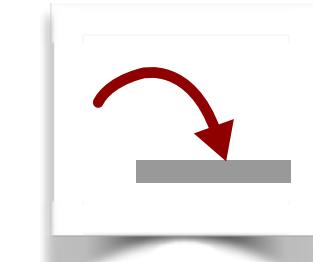
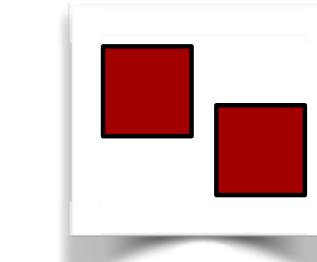
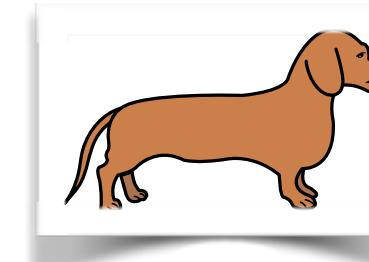
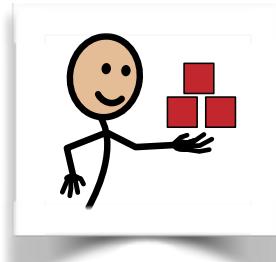
a message:

<these> <dog> <m:plural> <at> <home>

English:

<these> <dogs> <are> <at> <home>

icon:



<these> <dog> <plural> <at> <home>

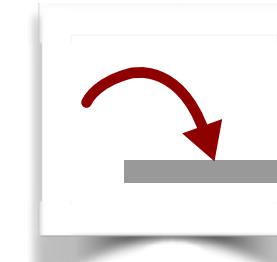
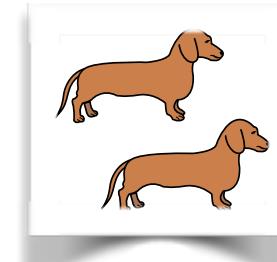
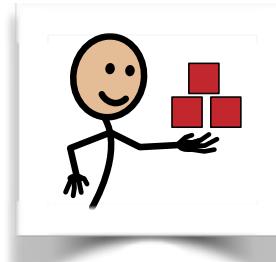
a message:

<these> <dog> <m:plural> <at> <home>

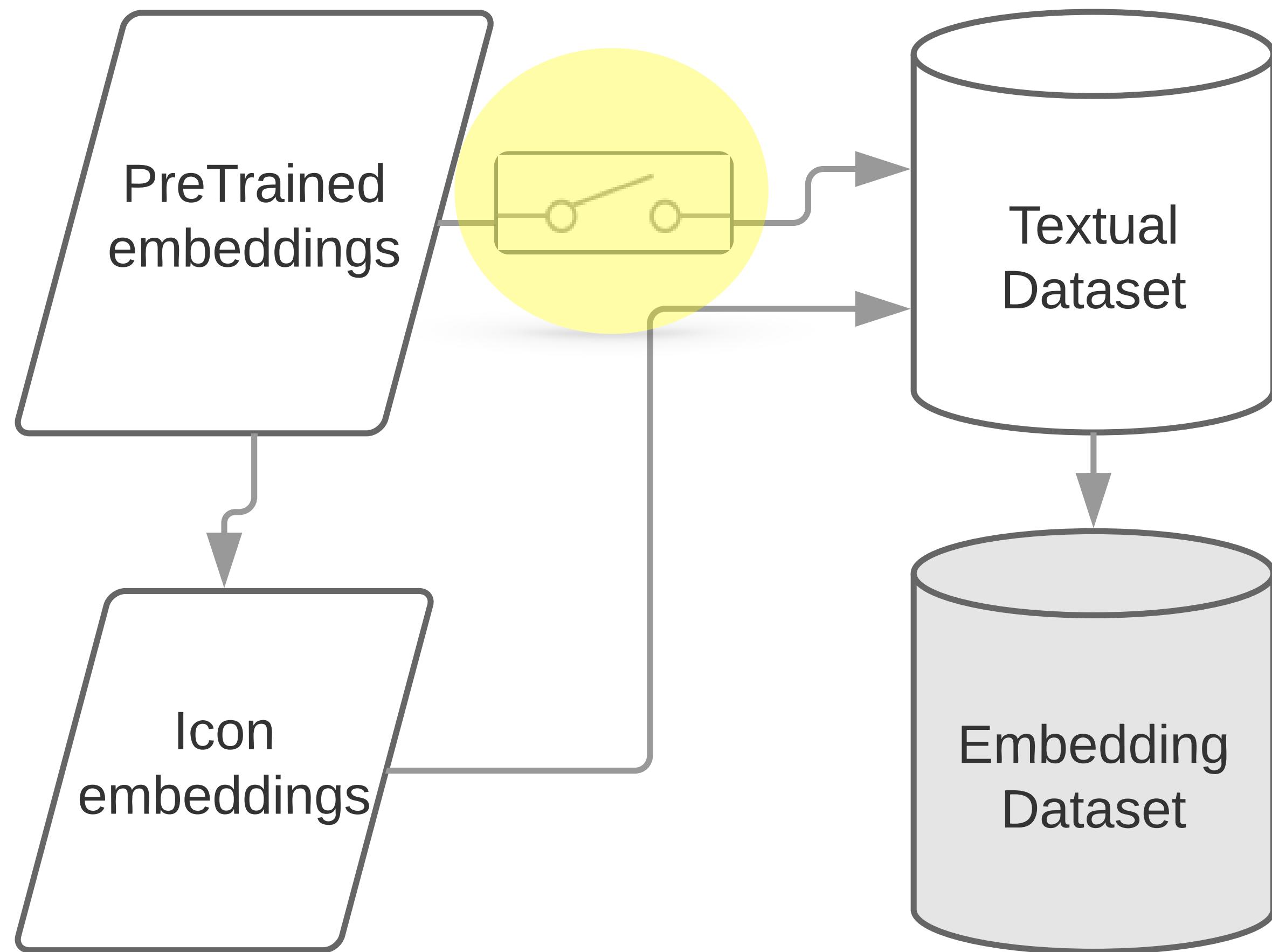
English:

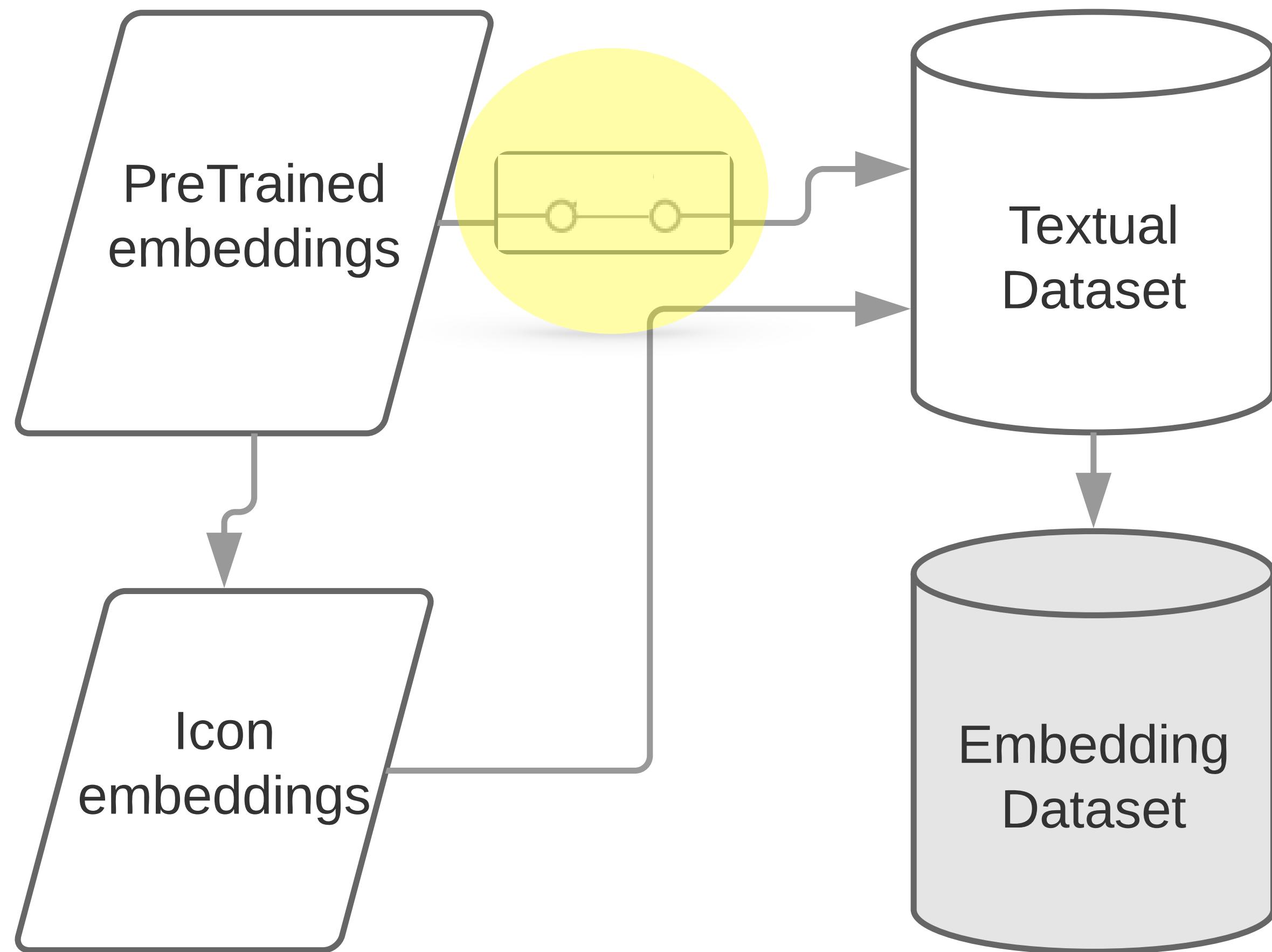
<these> <dogs> <are> <at> <home>

icon:



<these> <dogs> <at> <home>





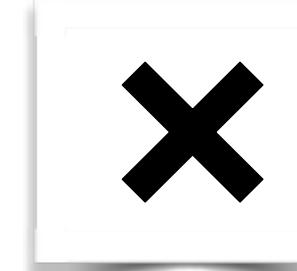
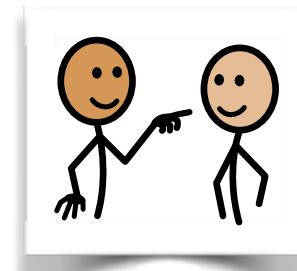
# Icon constraint experiment

English: “your warning did not work”

# Icon constraint experiment

English: “your warning did not work”

non-pure:

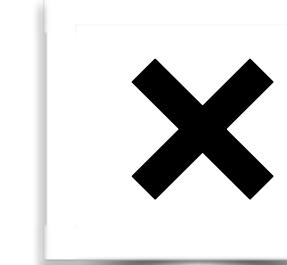
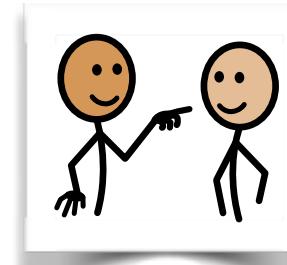


<your> <warning> <did> <not> <work>

# Icon constraint experiment

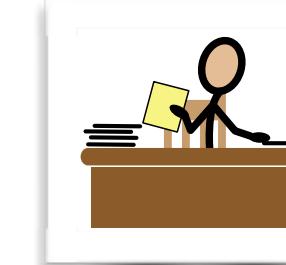
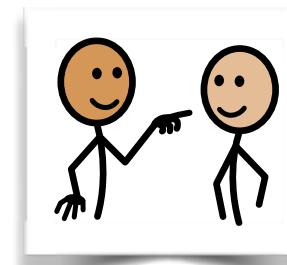
English: “your warning did not work”

non-pure:



<your> <warning> <did> <not> <work>

pure:



<your> <warning> <not> <work>



# Icon constraint experiment

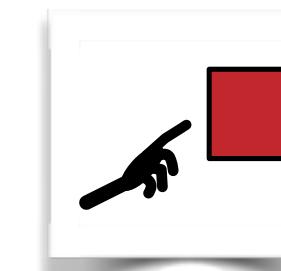
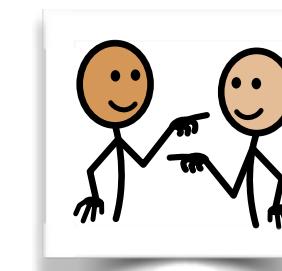
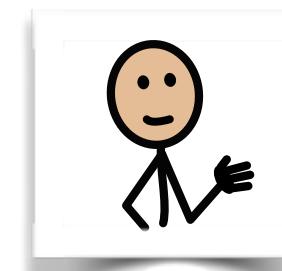
English: “so you did it”

non-pure:

# Icon constraint experiment

English: “so you did it”

non-pure:

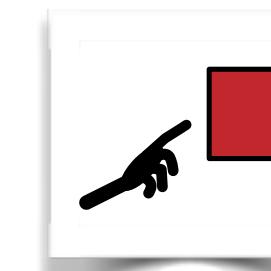
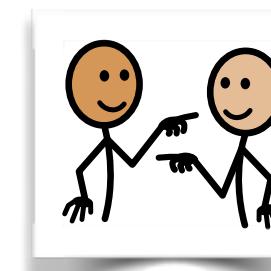
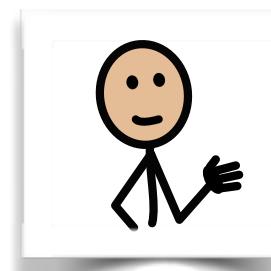


<so> <you> <did> <it>

# Icon constraint experiment

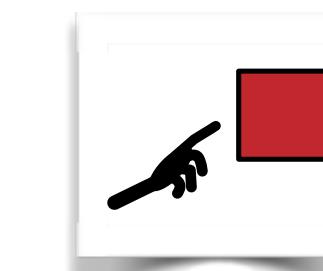
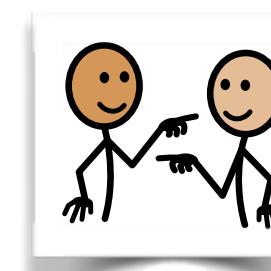
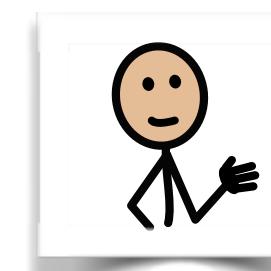
English: “so you did it”

non-pure:



<so> <you> <did> <it>

pure:



<so> <you> <it>



## Main Limitation:

Main Limitation or Advantage:

Icon language projection on textual language

Main Limitation or Advantage:

Icon language projection on textual language

Main Goal:

Conveying the message while loosing up a little the grammar

Reducing the number of selections to convey a message for  
bci purposes

## Acknowledgements:

### Clinical team:

Brandon Eddy

Betts Peters

Melanie Fried-Oken

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David Smith

Shaobin Xu

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number 5R01DC009834-09



# Questions?