Natural Notation for the Domestic Internet of Things

Charith Perera[1], **Saeed Aghaee**[2], Alan Blackwell[2]

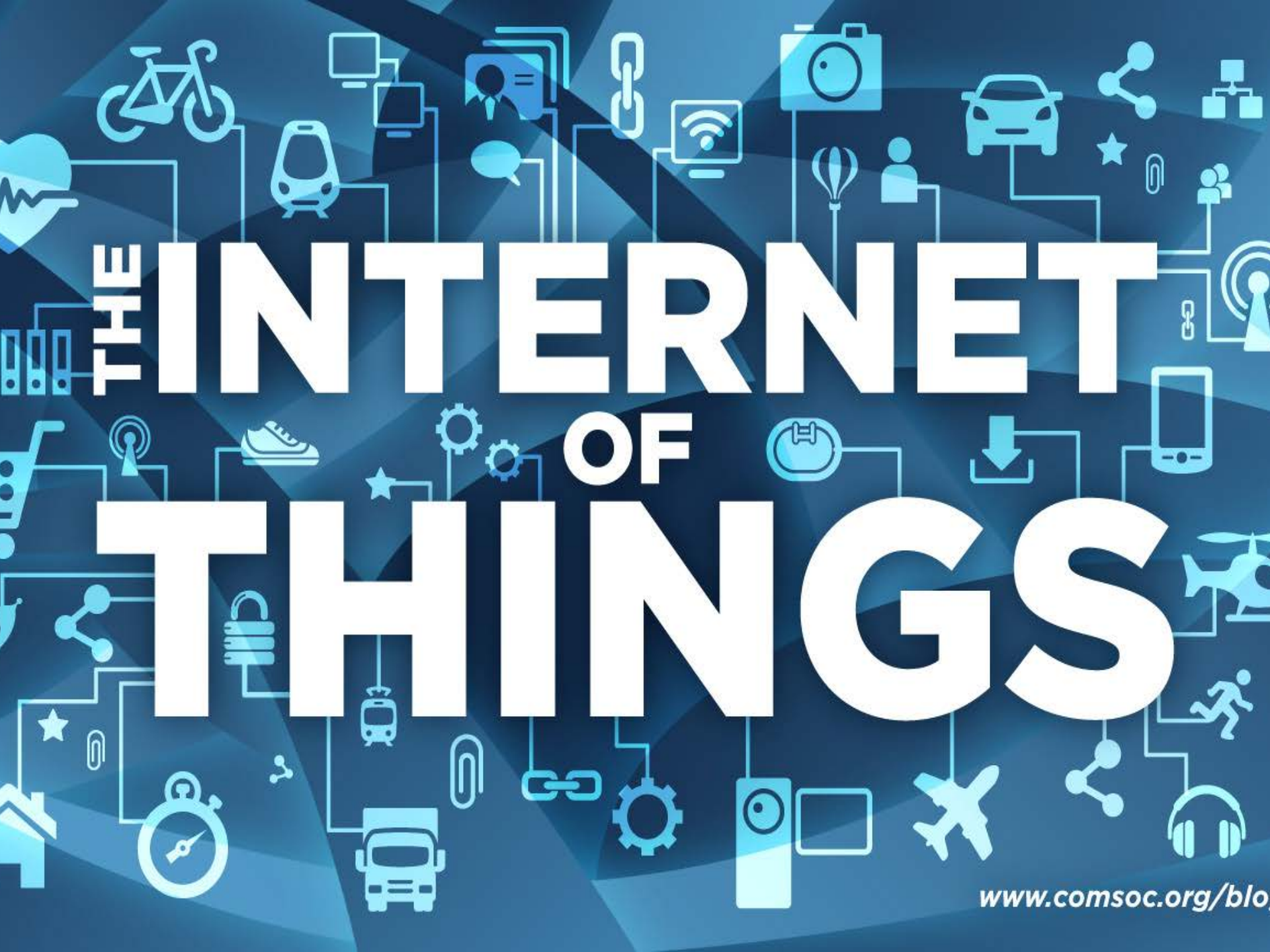
[1]Research School of Computer Science (RSCS) , The Australian National University, Canberra, ACT, Australia
[1]Faculty of Maths, Computing and Technology, The Open University, UK
[2]Computer Laboratory, University of Cambridge, Cambridge, UK

charith.perera@ieee.org , saeed.aghaee@cl.cam.ac.uk , alan.blackwell@cl.cam.ac.uk

The Open University

Australian National University

UNIVERSITY OF CAMBRIDGE


THE INTERNET OF THINGS
www.comsoc.org/blo

Internet of Things Applications

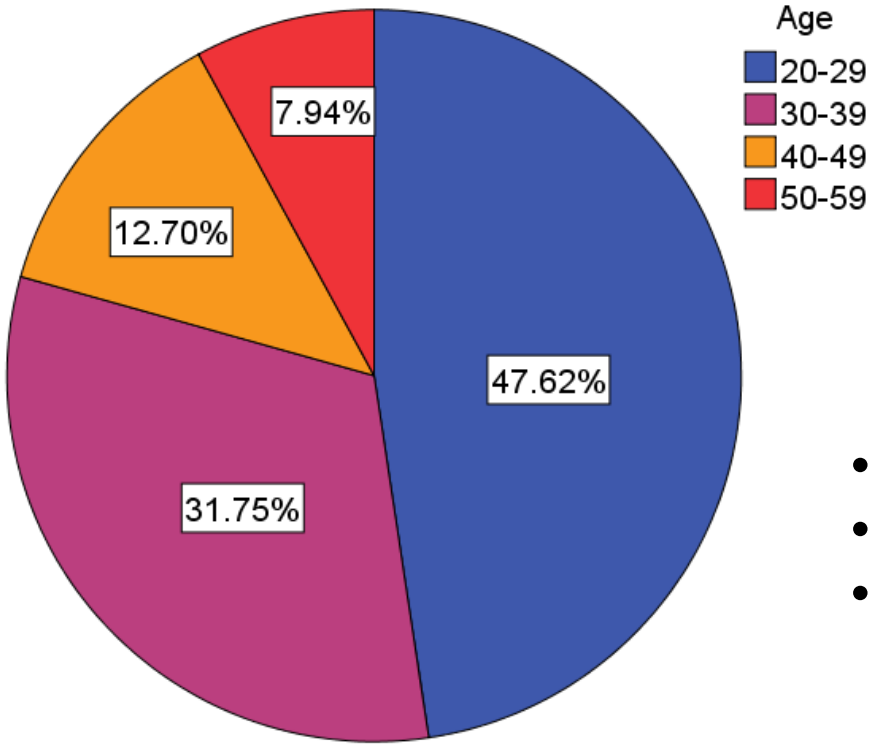
- Healthcare
- Retail
- Transportation and logistics
- Smart environments
  - Office
  - City
  - Home


Do I need an umbrella?
No rain is expected in San Francisco today.


iPad
10:15
59%
“Ok Google, remind me to buy more shampoo.”
Try the Google app

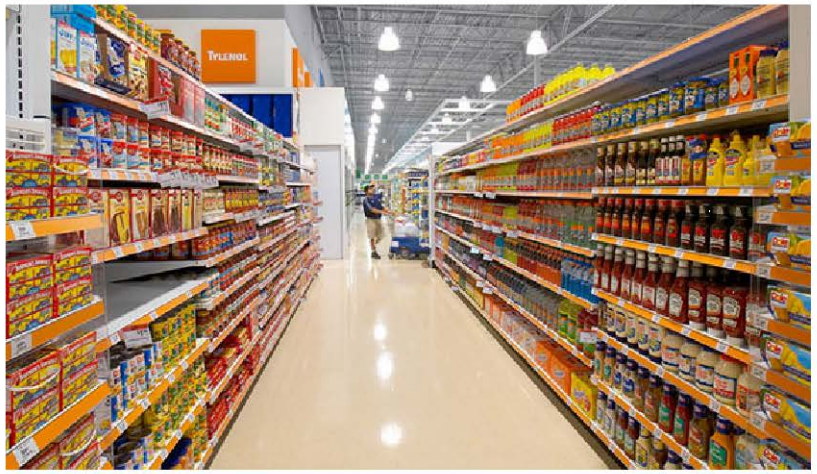
How do people give instructions in the home as an existing natural task?

Participants



- **63** participants in Canberra, Australia
- good working knowledge of **English**
- 38 were **male** (**60%**) and 25 **female** (**40%**)


Sticky notes as experimental medium



Problem:
Toilet paper roll is used up. You don't want to see this happen again.

How would you write a sticky note that will remind <u>YOU</u> to take necessary actions to solve this problem in the future in natural language ?

Tasks

Context	Problem
Laundry	Washing Machine filter is clogged. This happens roughly every 3 months
Kitchen	You have prepared food for your kids and about to leave your house. You won't come back until late. Leftover food can be spoiled if it is not placed in the fridge.
Bathroom	Toilet paper roll is used up. You don't want to see this happen again.
Garage	It is summer!!!.. Your parents have asked to bring your weed eater when you visit them next time. Every summer they need your weed eater to cut their lawn.
Living Room	Some relatives come to visit every few months... Your house is usually a mess
Garbage Bins	You always forget to put garbage bags into outside bins located in front of your house so the council will pick them up on Mondays

Tasks: Addressee

How would you write a sticky note that will

- (version 1) remind you
- (version 2) remind someone you are living with
- (version 3) be interpreted by a machine (an intelligent robot or something that can read sticky notes)

put rubbish in bin. (5)

put clothes in robe.

⋮

P19

P16 (5)

PLEASE

clean up
any mess.

On the first day of every (1)
month:
- Open filter on this machine.
- If it is congested, remove all matter.
- close filter.

P11

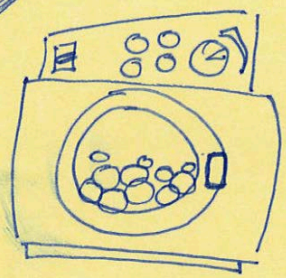
P18 (6)

Monday

Council garbage collecting day! ☺

(1)

CLEAN



P21

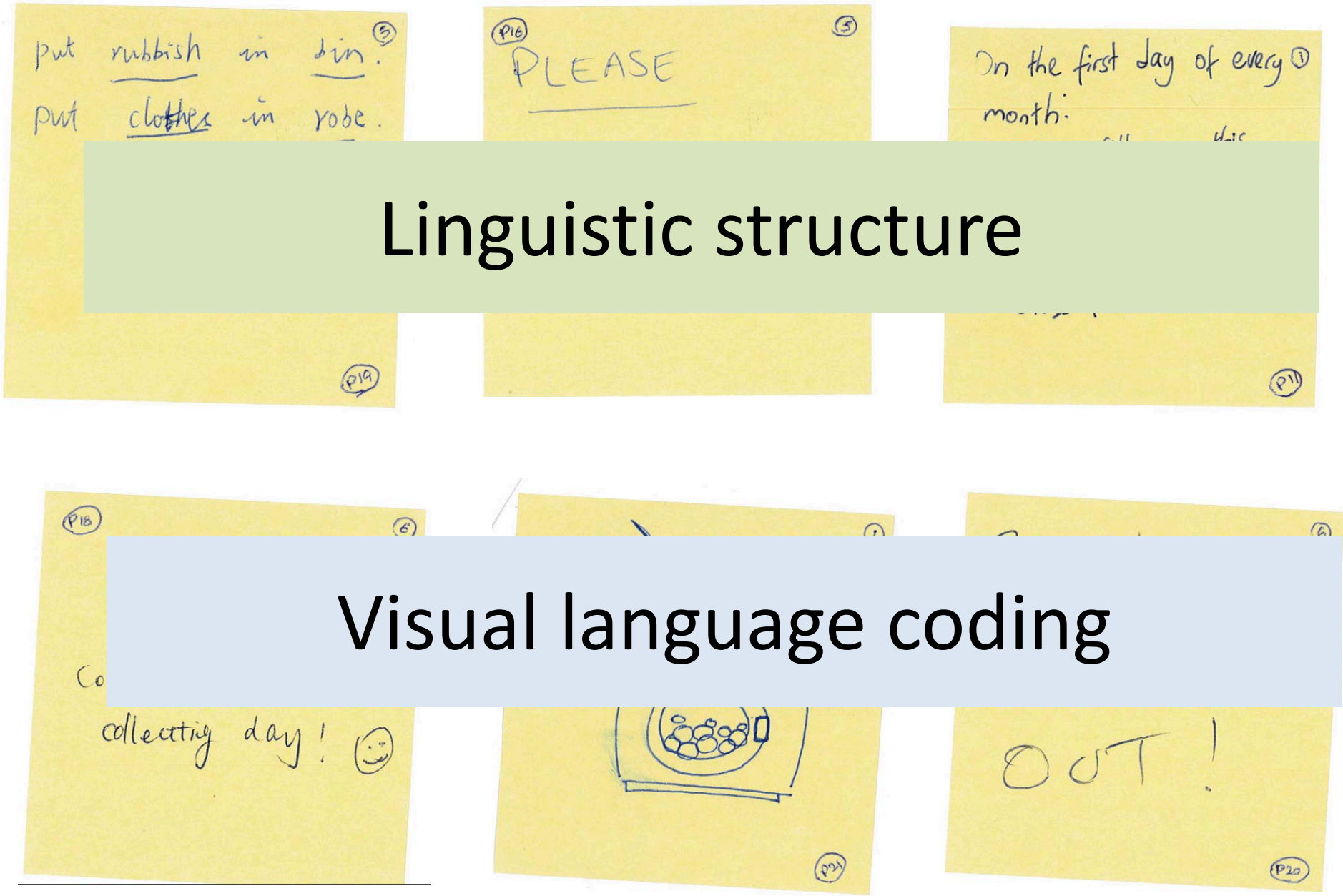
(6)

Remember:

BINS

OUT!

P20



Linguistic structure

Visual language coding

Linguistic Structure

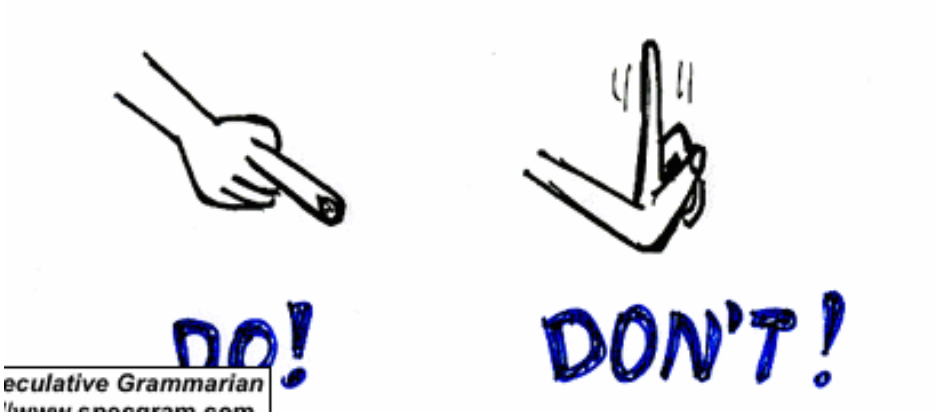
Linguistic Structure

Number of Words

The average number of words in a note addressed to yourself was significantly less than those addressed to someone else or to an intelligent machine

Linguistic Structure

Sentence Types



Sticky notes addressed to an intelligent machine and the participants themselves have, respectively, the least and the most number of imperative sentences

Linguistic Structure

Request Types

Significantly more male participants used a "request" phrases (remind, remember, don't forget, …)

Linguistic Structure

Causality

Technical experience and having a machine as an addressee positively affects the use of causal sentences (if, when, …)

Linguistic Structure

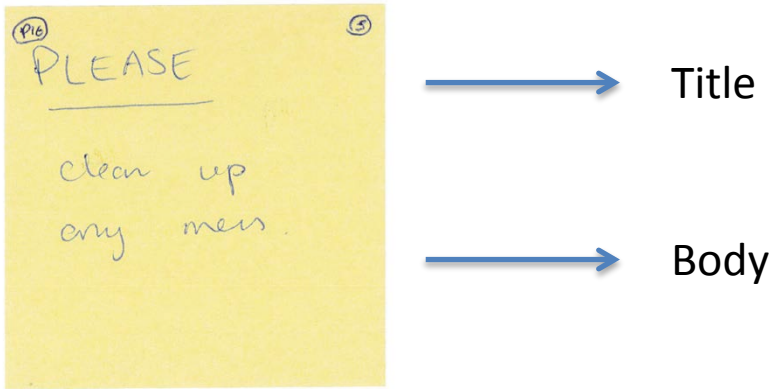
Speech Acts

The sentences are more likely to convey a directive speech act when addressed to an intelligent machine

Visual Language Coding

Visual Language Coding

Visual Regions



- Most cases divided the note into two distinct regions
- Vertical left-alignment was used to indicate items in a list
- Text arrangement within a region was most often conventionally left- and top-justified
- 11 cases showed consistent centre-alignment of the individual text lines

Visual Language Coding

Visual Symbols

- Alphabetic letters were usually lower case with conventional capitalisation
- After alphabetic letters, the most common symbol was use of an exclamation mark
- Algebraic symbols were used in 8 cases, often in ways that reflected typical programming language practice.
- Smiley emoticons were used 6 times

Visual Language Coding

Visual Semantics

A technically specialised visual vocabulary was being used

Visual Language Coding

Visual Pragmatics

Do people adjust the visual language grammar they use when they are writing a sticky note addressed to an intelligent machine, rather than another person?

1. **H1**: that there is an identifiable subset (or 'dialect', perhaps) of visual language features that are more often used when addressing machines rather than people

2. **H2**: that there is a complementary set of visual language features that are more often used when addressing people rather than machines

3. **H3**: that people with prior experience of programming are more likely to use an identifiable subset of visual language features when addressing machines

Implications for Design

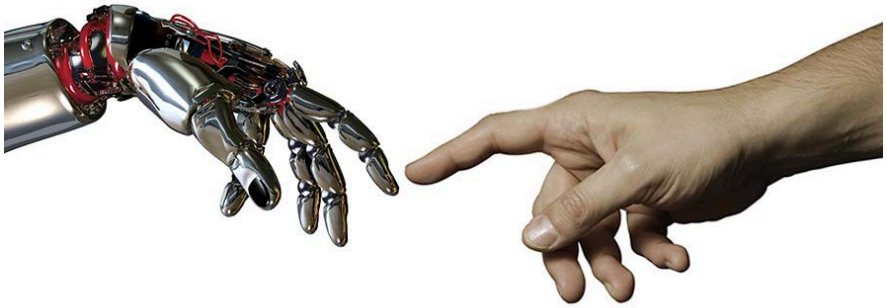
Implications for Design

Multimodal interface

We have shown that the graphical resources of the sticky note complement natural language understanding, by allowing the use of visual language cues that establish the context for instruction, drawing on a number of commonplace graphical conventions

Implications for Design

Human vs. Machine



The difference in the attitude of end-users towards the communication target should be taken into account while designing the user experience for smart home systems.

Implications for Design

Expressive Power

More detailed specification, with syntactic and semantic forms that resemble programming language constructs

Implications for Design

IF vs. WHEN

While a trigger such as ‘relatives paying a visit’ is accommodated in emerging event-based mashup paradigms (e.g. IFTTT), the attention investment required for modal reasoning about temporal context such as “when” may involve more sophisticated combinations of natural language and other notational devices

Natural Notation for the Domestic Internet of Things

Charith Perera[1], Saeed Aghaee[2], Alan Blackwell[2]

[1]Research School of Computer Science (RSCS) , The Australian National University, Canberra, ACT, Australia
[1]Faculty of Maths, Computing and Technology, The Open University, UK
[2]Computer Laboratory, University of Cambridge, Cambridge, UK

charith.perera@ieee.org , saeed.aghaee@cl.cam.ac.uk , alan.blackwell@cl.cam.ac.uk

The Open University

Australian National University

UNIVERSITY OF CAMBRIDGE