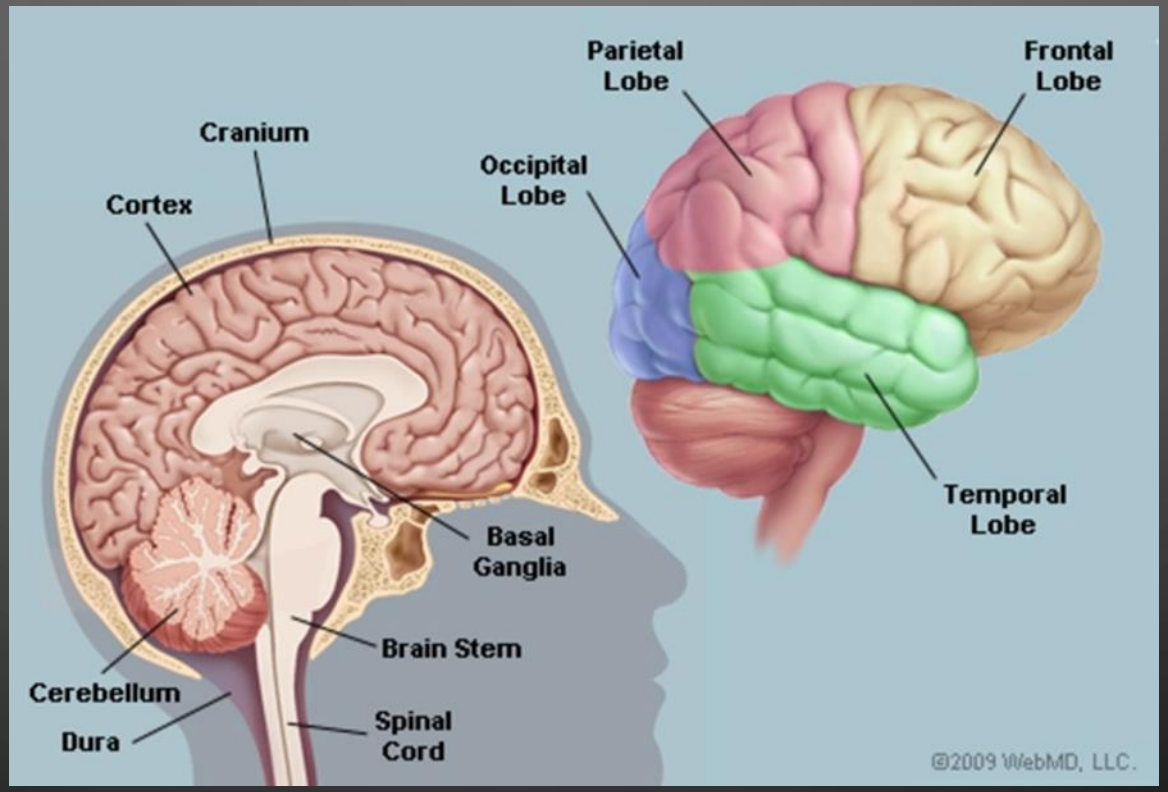
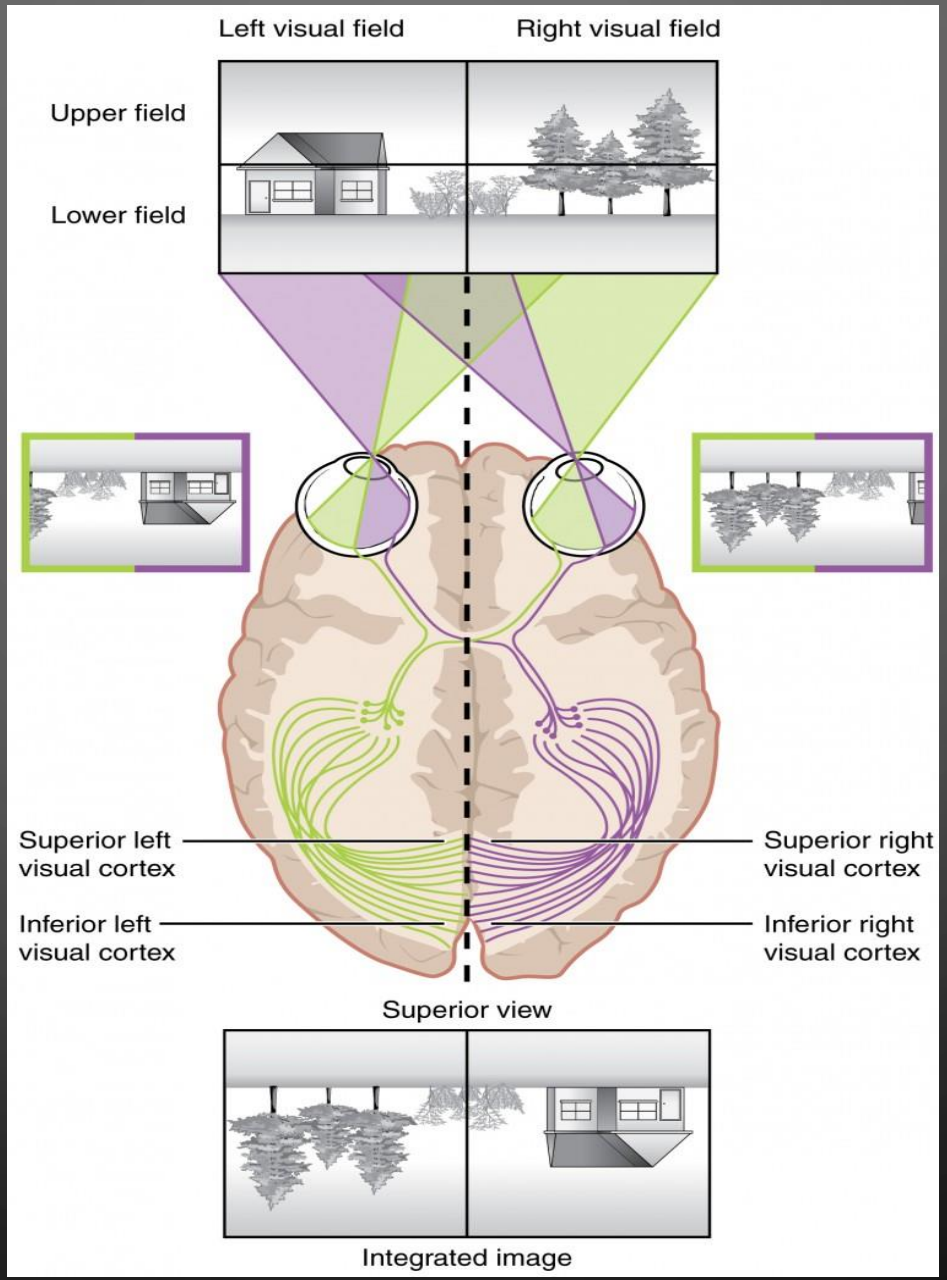
What's your occipital lobe looking at?

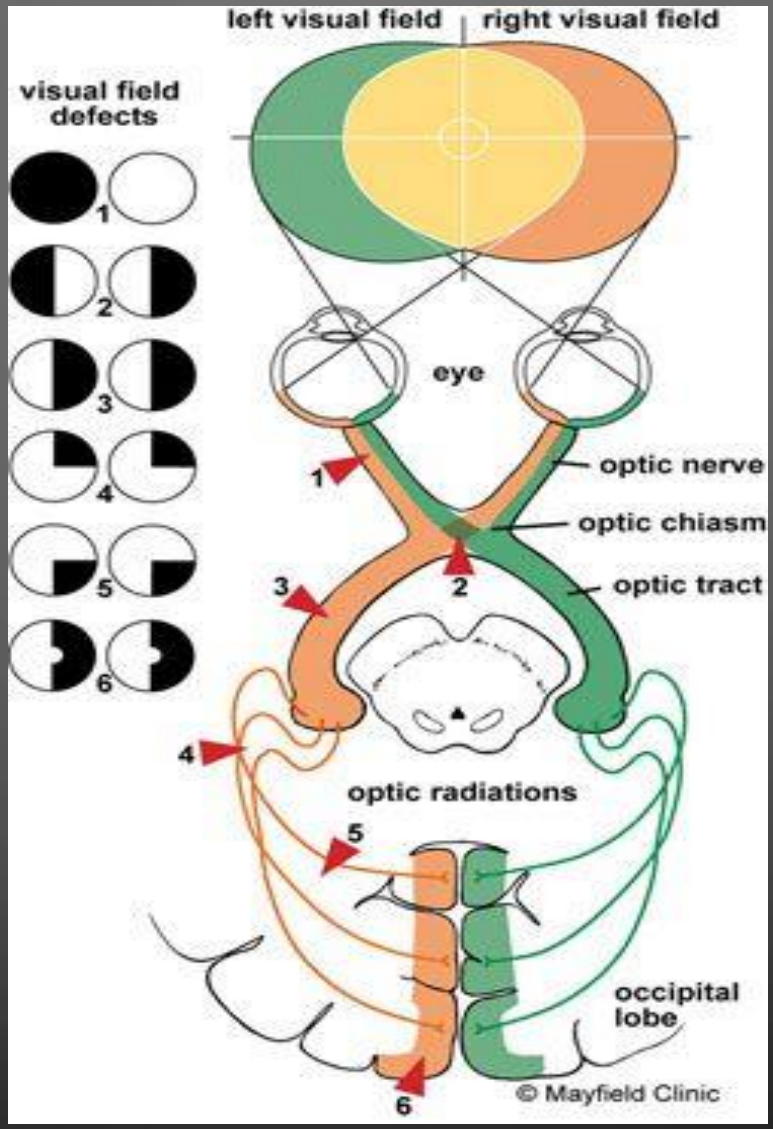
Gaze patterns and non-verbal cue detection

Vidya Somashekarappa
PhD Candidate
CLASP, University of Gothenburg

Occipital lobe → Visual cortex




Left visual field
Right visual field
Upper field
Lower field
Superior left visual cortex
Superior right visual cortex
Inferior left visual cortex
Inferior right visual cortex
Superior view
Integrated image


left visual field
right visual field
visual field defects
1
2
3
4
5
6
eye
optic nerve
optic chiasm
optic tract
optic radiations
occipital lobe
© Mayfield Clinic

Gaze?

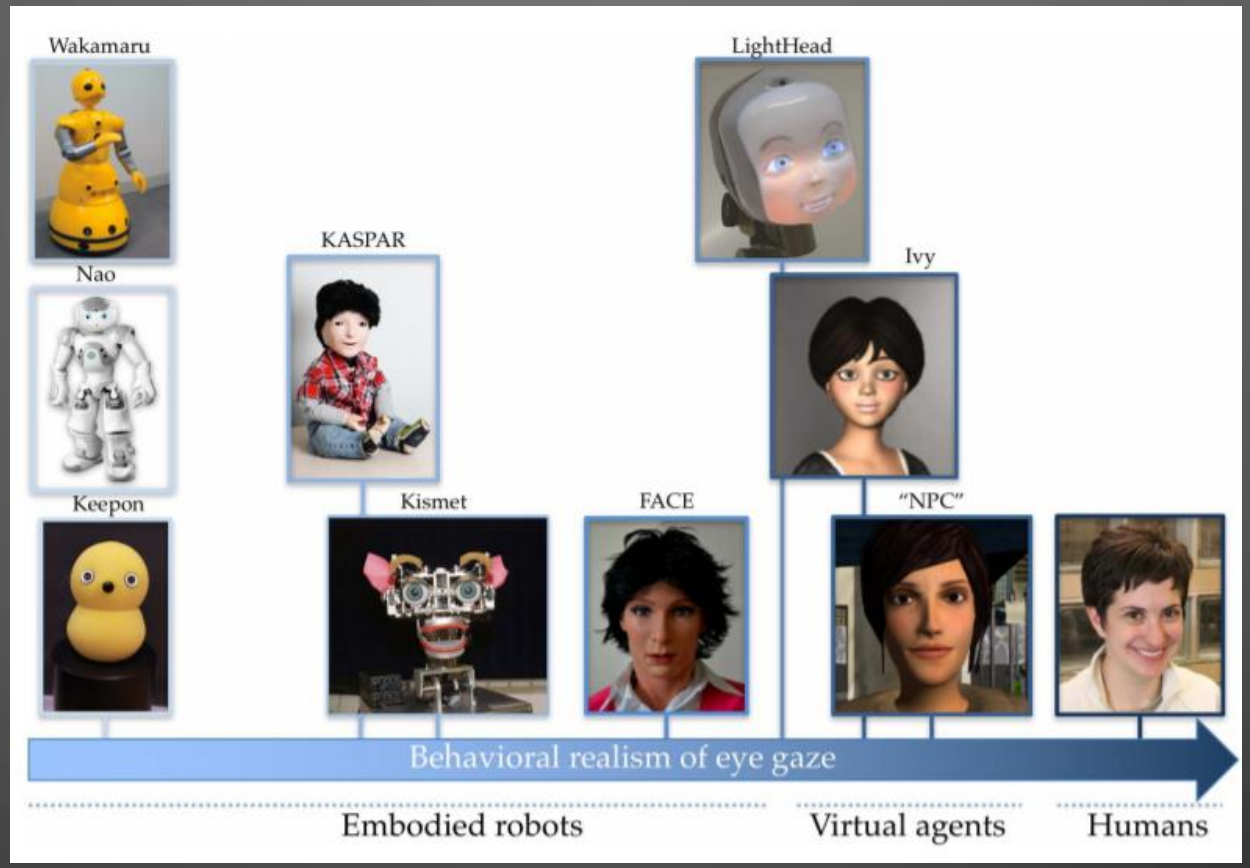
To look steadily and intently, as with great curiosity, interest, pleasure, or wonder

Mutual gaze is often referred to as “eye contact” and it is eye gaze that is directed from one agent to another’s eyes or face, and vice versa

Referential gaze or deictic gaze is gaze directed at an object or location in space

Joint attention involves sharing attentional focus on a common object (Moore & Dunham, 2014)

Gaze aversions are shifts of gaze away from the main direction of gaze, which is typically a partner’s face



Wakamaru (Szafir & Mutlu, 2012), Nao (Aldebaran, 2015), Keepon (author photograph), KASPAR (courtesy of the Adaptive Systems Research Group, University of Hertfordshire, UK), Kismet (Breazeal & Scassellati, 1999a), FACE (Zaraki, Mazzei, Giuliani, & De Rossi, 2014), LightHead (Delaunay, 2015), Ivy (Andrist, Mutlu, & Gleicher, 2013), and an NPC (Normoyle et al., 2013)

Interaction with Eye Gaze

Explicit Interaction:
Open interaction with a system where humans intentionally input discrete commands to explicitly express their needs

Implicit Interaction:
Information that people convey indirectly in a conversation, but which may be derived from dialogue and context information.

Unconscious Interaction:
Continuous (often nonverbal) behavior people not voluntarily control, but which may be (but are not necessarily expected to be) interpreted as the implicit expression of a particular need or intention

Gaze in HRI

Human-focused: This research aims to understand the characteristics of human behavior during interactions with robots

Design-focused: This research investigates how design choices about a robot, such as its appearance or behavior, can impact interactions with humans

Technology-focused: This research aims to build computational tools for generating robot eye gaze in human-robot interactions.

Gaze Technology

Marketing Strategy Analysis	Cognitive Research	Medical Education
[Zamani et al. 2016]	[Kiefer et al. 2017]	[Kok et al. 2017]

Gaze-based Interaction [Pfeiffer et al. 2008]	Collaborative System [Zhang et al. 2017]	Gaze-contingent Eyeglasses [Padmanaban et al. 2019]

Gaze in dialogue

Gaze is viewed as a display of attention and engagement

1. Social Gaze
2. Referential Gaze

Social Gaze

- listeners display longer uninterrupted gaze towards the speaker
- speakers tend to shift their gaze towards and away from the listener
- unaddressed participants looking towards the projected next speaker before the completion of the ongoing turn
- gaze aversion can be observed in a speaker briefly after taking their turn before returning gaze to their primary recipient closer to turn completion

Referential gaze

- The process of identifying application-specific entities which are referred by linguistic expressions is reference resolution

- referential gaze cues reduce linguistic cognitive load, in the context of sentence processing and workload

- gaze acts as an early disambiguator of referring expression

- visual input has a immediate effect on language interpretation

Are the existing robots sophisticated enough to carryout all the above intentions effectively?

Goals

1) Annotate eye gaze in dialogue

2) Develop an automated system for gaze coordination during conversation

3) Understand the speech transition (context of the topic) in correlation to gaze transition

4) Does speech draw gaze attention/gaze draw speech attention

5) Gaze prediction based on referential speech and gaze attention

6) Implement human like gaze behaviour in avatar/robot

Gaze Annotation in Multi-modal Interaction

-Detailed view of the interaction between visual, verbal and bodily feature

-The measurement of gaze points and eye movements with eye-tracking techniques during online behaviour has influenced multiple areas of research in psycholinguistics and psychology

But….

Less attention towards production

Multi-modal Corpus

Corpus	Camera perspective	Context of gaze
CID corpus	Single (Frontal View)	Social
Nottingham Multimodal Corpus(NMMC)	Multiple angle	Social
Swedish Spontaneous Dialogue Corpus (Spontal corpus)	Multiple angle	Social
IFA dialogue video corpus (IFADV)	Multiple angle	Referential
Good-Housekeeping Institute Corpus (GHI)	Multiple angle	Social and Referential

Methods and Materials

1) Recordings: Recording setup, recording devices

2) Participants

Recordings: Recording setup, recording devices

Participants

- Twenty four dyads recruited from staff at the Good Housekeeping Institute

-In each session a pair of participants taste-tested eight different types of hummus in the GHI test kitchen and provided ratings on a single (shared) questionnaire

-20-30 minute sessions

Annotation

1) Annotation tool
2) Gaze Annotation

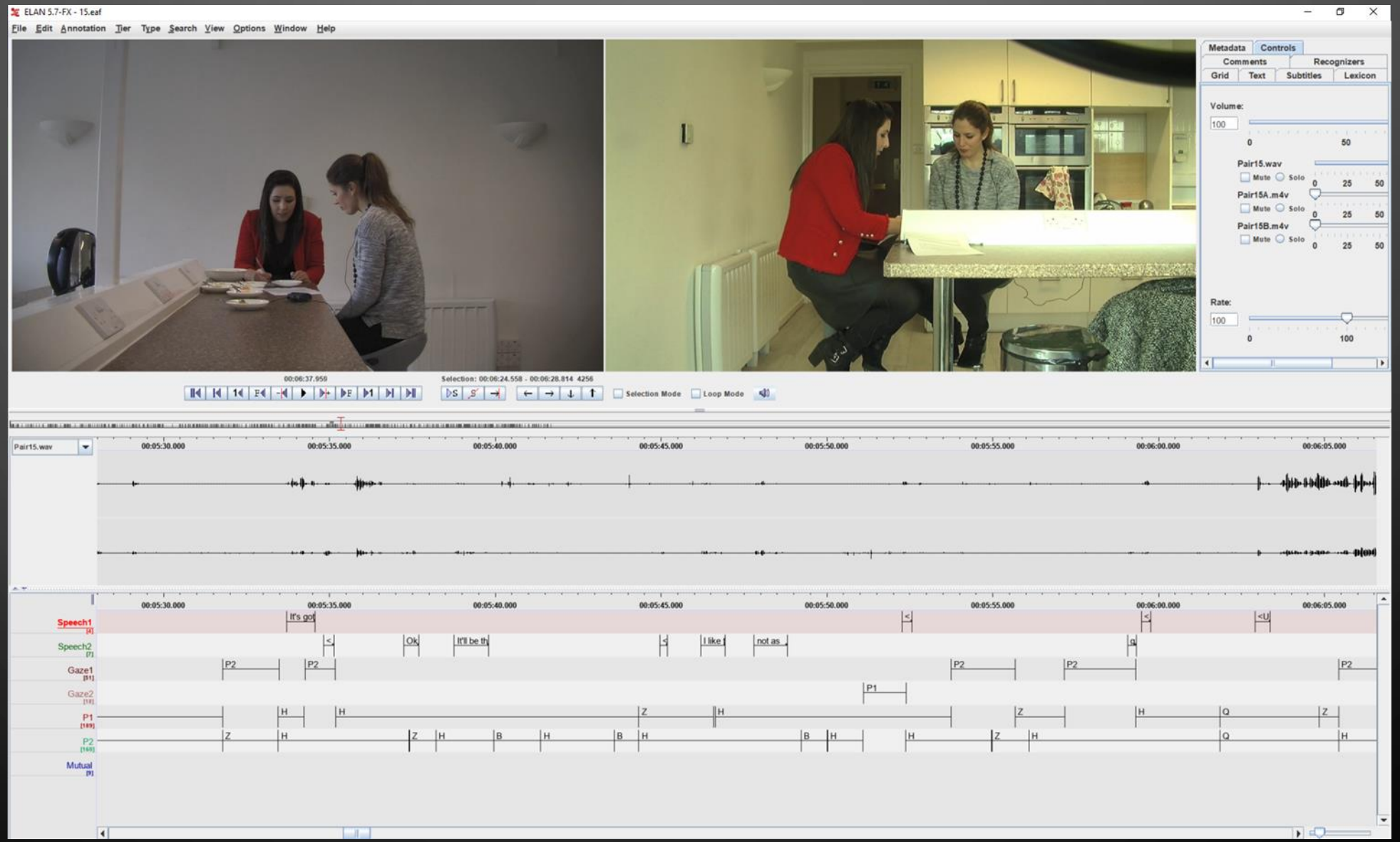
Annotation tool

-Data was annotated in ELAN (Berez, 2007), a tool that provides a framework for annotation of audio and video recordings

-Transcription: General norms and principles of Gesprächsanalytisches Transkriptionssystem (GAT) (Selting et al, 1998)

Gaze Annotation

1) Gaze1 and Gaze2
2) P1 and P2
3) Mutual attention (MA)
4) Joint Attention (JA)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File Edit Annotation Tier Type Search View Options Window Help
Metadata Controls
Comments Recognizers
Grid Text Subtitles Lexicon
Volume:
Pair15.wav
Pair15A.m4v
Pair15B.m4v
Mute Solo
Rate:
Selection Mode
Loop Mode
Speech1
Speech2
Gaze1
Gaze2
P1
P2
Mutual
It's got
Ok
It'll be th
I like
not as

Qualitative Analysis

1) Co-occurrence of gaze attention with particular dialogue acts or point where the floor change occured

2) Participants gave less feedback and looked at the partner more during the task when the preceding utterance segment was incomplete

3) Shared attention on objects in the visual field was task oriented with higher engagement

4) Reference resolution was aided by gaze

https://www.aclweb.org/anthology/2020.lrec-1.95/

7) Agreement in speech in relation to gaze

8) A significant trend in gaze duration patterns changed across familiarization

9) Eye gaze can be used to signal both the end and the beginning of a speaking turn during social interaction

https://www.aclweb.org/anthology/2020.lrec-1.95/

Annotation Video

Points for discussion

1) Gaze agreement/disagreement prediction before the emergence of linguistic cues
2) Human-like gaze cues help to improve performance during a task
3) The influence of decision-making on eye gaze behavior
4) Gaze behaviour to improve task performance and reduce cognitive load by helping to disambiguate referring expressions to objects in a shared scene and manage the flow of interaction
5) Time spent on attending to the partner (G1 and G2)
6) Gaze behaviour affected by particular constraints
7) Relationship between gaze and judgements of friendliness
8) How participants perform gaze motions for successful conveyance of emotional state