An Estimation of Certainty for Multiple Choice Responses using Eye-movement

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Common BELIEF in communication

- Communication is the sharing of a common belief about a topic [Iwahashi 2003].
  - Certainty: there is good communication
- Uncertainty
  - Unstable eye-movement associated with uncertainness [Underwood 2005]
  - The phenomenon has already applied to detecting relevant text [Puolamaeki et al. 2005]
- To examine whether eye-movement based on certainty can be an idex of the “strength of belief (SOB)” for answers to a multiple choice task.

Multiple choice task

Multiple choice questionnaire

課題01 「くだもの」 0：50

果物	品種名 1	品種名 2	品種名 3	品種名 4
りんご	マスカット とちおとめ デリシャス 福原	バレンシア 紅玉 あまおう デラウェア	鈴木 巨峰 女峰 世界一	とよのか マッキントッシュ ワシントン 甲州
オレンジ	マスカット とちおとめ デリシャス 福原	バレンシア 紅玉 あまおう デラウェア	鈴木 巨峰 女峰 世界一	とよのか マッキントッシュ ワシントン 甲州
ぶどう	マスカット とちおとめ デリシャス 福原	バレンシア 紅玉 あまおう デラウェア	鈴木 巨峰 女峰 世界一	とよのか マッキントッシュ ワシントン 甲州
いちご	マスカット とちおとめ デリシャス 福原	バレンシア 紅玉 あまおう デラウェア	鈴木 巨峰 女峰 世界一	とよのか マッキントッシュ ワシントン 甲州

次へ

Multiple choice task

Review the answer during the second minute.

課題01 「くだもの」 0：20

果物	品種名 1	品種名 2	品種名 3	品種名 4
りんご	福原 戻る	紅玉 戻る	世界一 戻る	マッキントッシュ 戻る
オレンジ	デリシャス 戻る	バレンシア 戻る	鈴木 戻る	ワシントン 戻る
ぶどう	マスカット 戻る	デラウェア 戻る	巨峰 戻る	甲州 戻る
いちご	とちおとめ 戻る	あまおう 戻る	女峰 戻る	とよのか 戻る

次へ

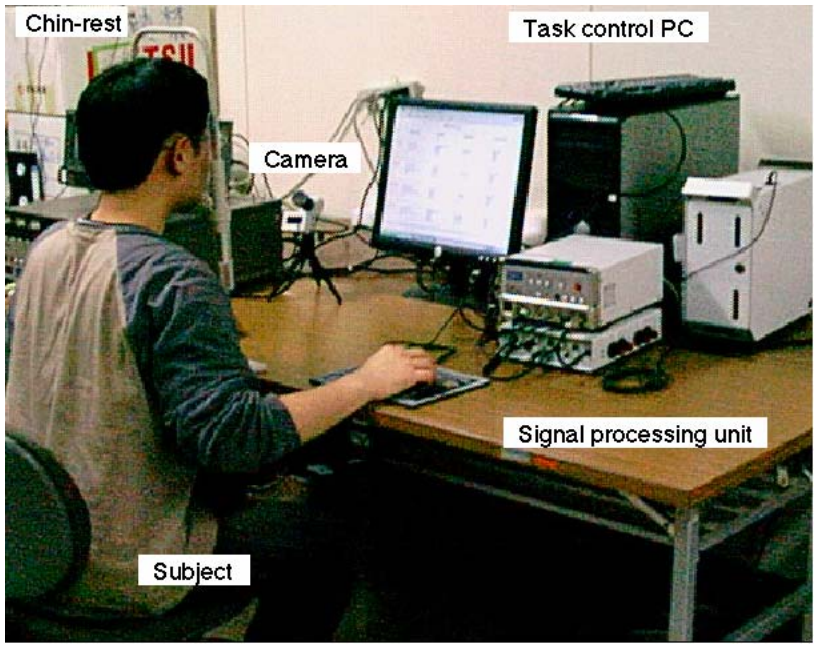
Multiple choice task English example

Task01 "Region" 0:20

County	Series1		Series2		Series 1	Series 2
France	Paris Roma	Berlin Washington D.C.	Napa Mosel	Bourgone Toscana	Paris Back	Bourgogne Back
Germany	Paris Roma	Berlin Washington D.C.	Napa Mosel	Bourgone Toscana	Belrin Back	Mosel Back
Italy	Paris Roma	Berlin Washington D.C.	Napa Mosel	Bourgone Toscana	Roma Back	Toscan Back
U.S.A.	Paris Roma	Berlin Washington D.C.	Napa Mosel	Bourgone Toscana	Washington D.C. Back	Napa Back

Next

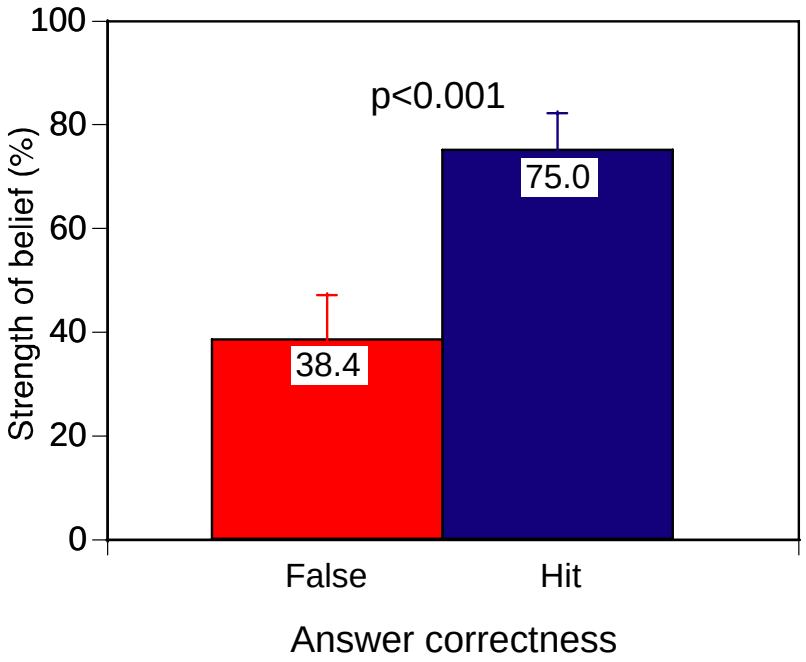
Experiment

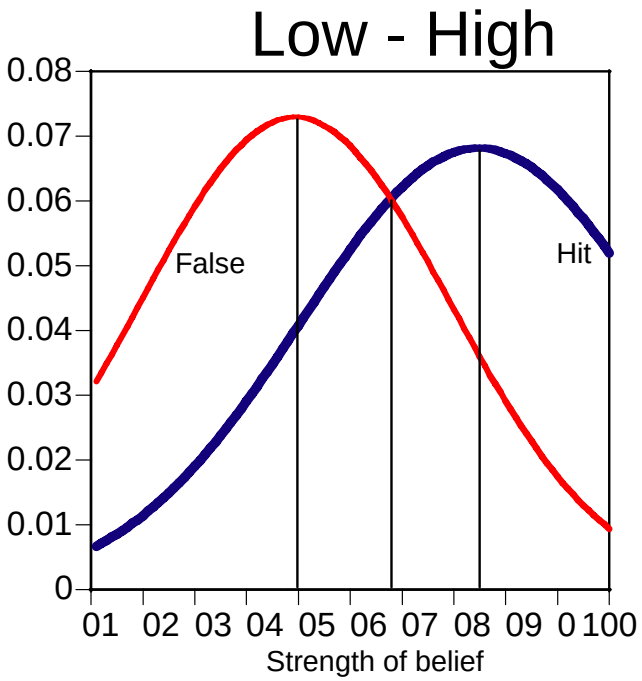


- Eye-movements were observed using a video-based eye tracker (nac:EMR-8NL)
- The subject rested his head on a chin rest, a small infra-red camera was positioned between the subject and the monitor.
- Eye-movement was tracked on a 800 by 600 pixel screen at 60 Hz.
- Eye-movements were divided into saccades and gazes.

Strength of belief (SOB)

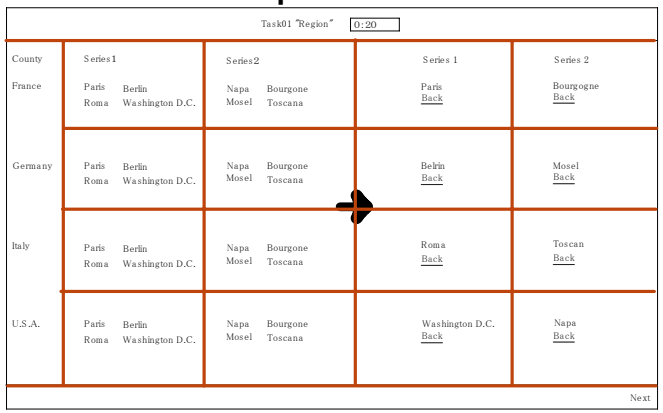
- Subjective certainty as SOB on a scale between 0 to 100.
- Each subject reviewed three sets of tasks so that in total 48 SOBs were reported.





Low certainty for the answer

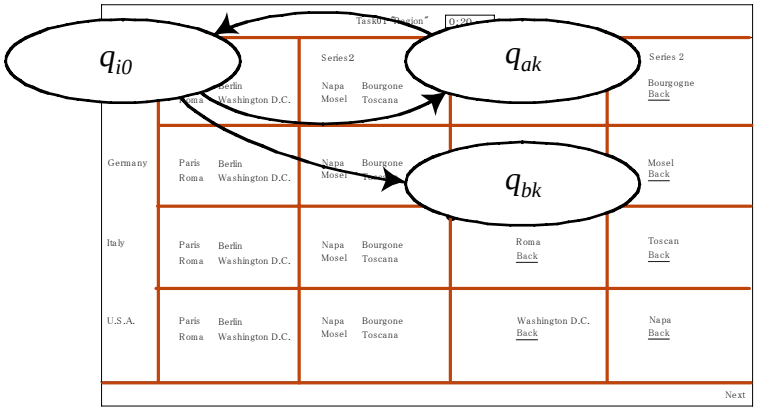
Gaze points were classified into 16 cells and question items.



Initial set: High SOB

Question item

A multiple choice cell



q_{ak}: Low SOB

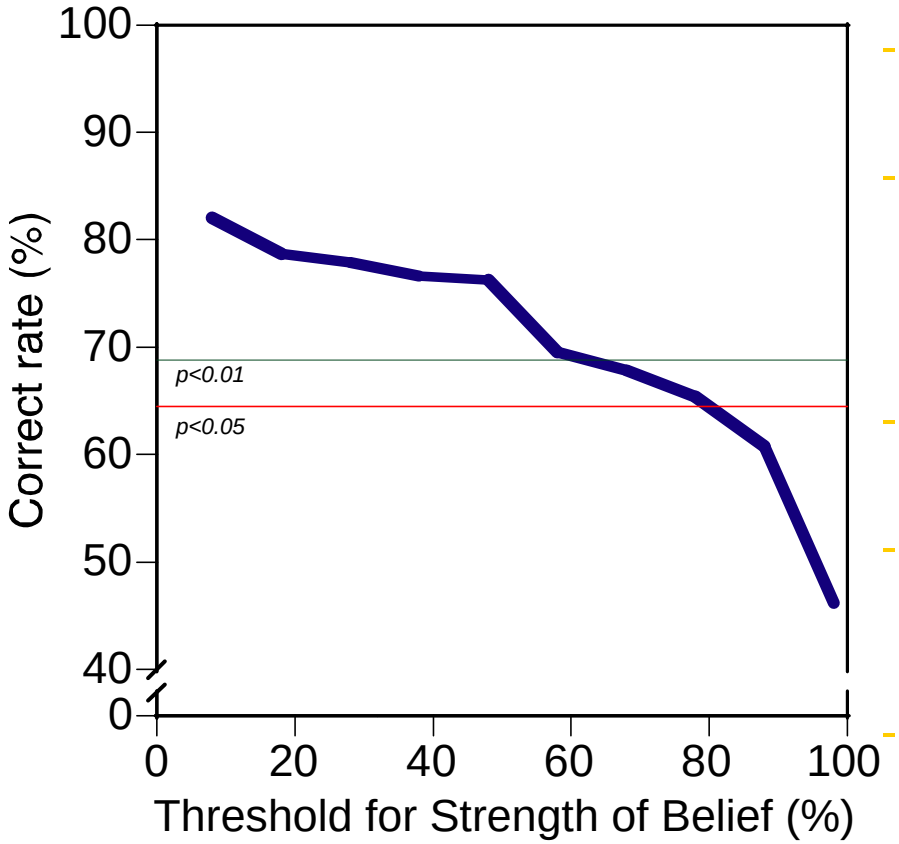
	Subject report	
Eye-Movement estimation	SOB [High]	SOB[Low]
SOB[High]	57.5	24.1
SOB[Low]	7.1	11.3

Correct rate

68.8%

($p<0.05$)

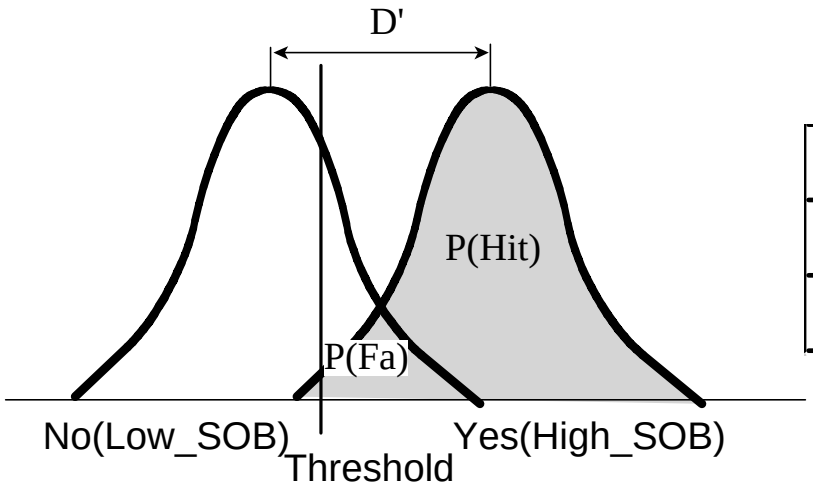
Correct rate change with SOB



- The correct rate may depend on the threshold for SOB.
- The rate was investigated in accordance with the threshold, which was adjusted from 0 to 100.
- The correct rate decreases with the threshold for SOB.
- A significant correct rate is obtained when the threshold is lower than 60%.
- This suggests a scan-path between a question item and an answer area appears when a SOB report is low.

Discriminability for SOB

- Signal Detection Theory (SDT) is introduced to evaluate discrimination performance.
- D' shows discriminability for high and low SOB.
- The average discriminability using eye-movements is 34% (0.35/1.03) of subject's reports.



	Mean D'
Eye-movement	0.35
Subject report	1.03

Summary

- To examine the feasibility of estimating the degree of “strength of belief (SOB)” of responses using eye-movement, the scan-path of eye-movements were analyzed while subjects reviewed their own responses to multiple choice tasks.
- Comparing subject’s reports of high and low SOB and eye-movement estimations, a significant correct rate of discrimination was observed.
- These results provide evidence that SOB can be estimated using eye-movement.