

Towards the ISO 24617-2-compliant Typology of Metacognitive Events

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Outline

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Motivation | Objectives

Taxonomy of Metacognition

Conceptual Overview

Assessment of Metacognition

Self-reporting | Verbalization | Psycho-physiological measurement | Interaction-based approach

DIT and ISO-26417-2 metacognitive events

Levels | Tentative Mapping

Experimental design

Use case | Data collection | Data processing

Expected outcomes

Introduction | motivation

Self-awareness, self-regulation, forethought, logical reasoning, creativity, empathy, perspective-taking and the mindfulness of others are some of the key features that make us **truly human**

Metacognition

- significant for everyday **problem-solving** and **decision-making**
 - guides and regulates human intelligent behaviour
 - improves task performance and learning
 - facilitates social regulation

In Dialogue Systems

- transforms the system from a reactive dialogue participant into a **proactive** learner, accomplished **multi-tasking** planner and **adaptive** decision maker



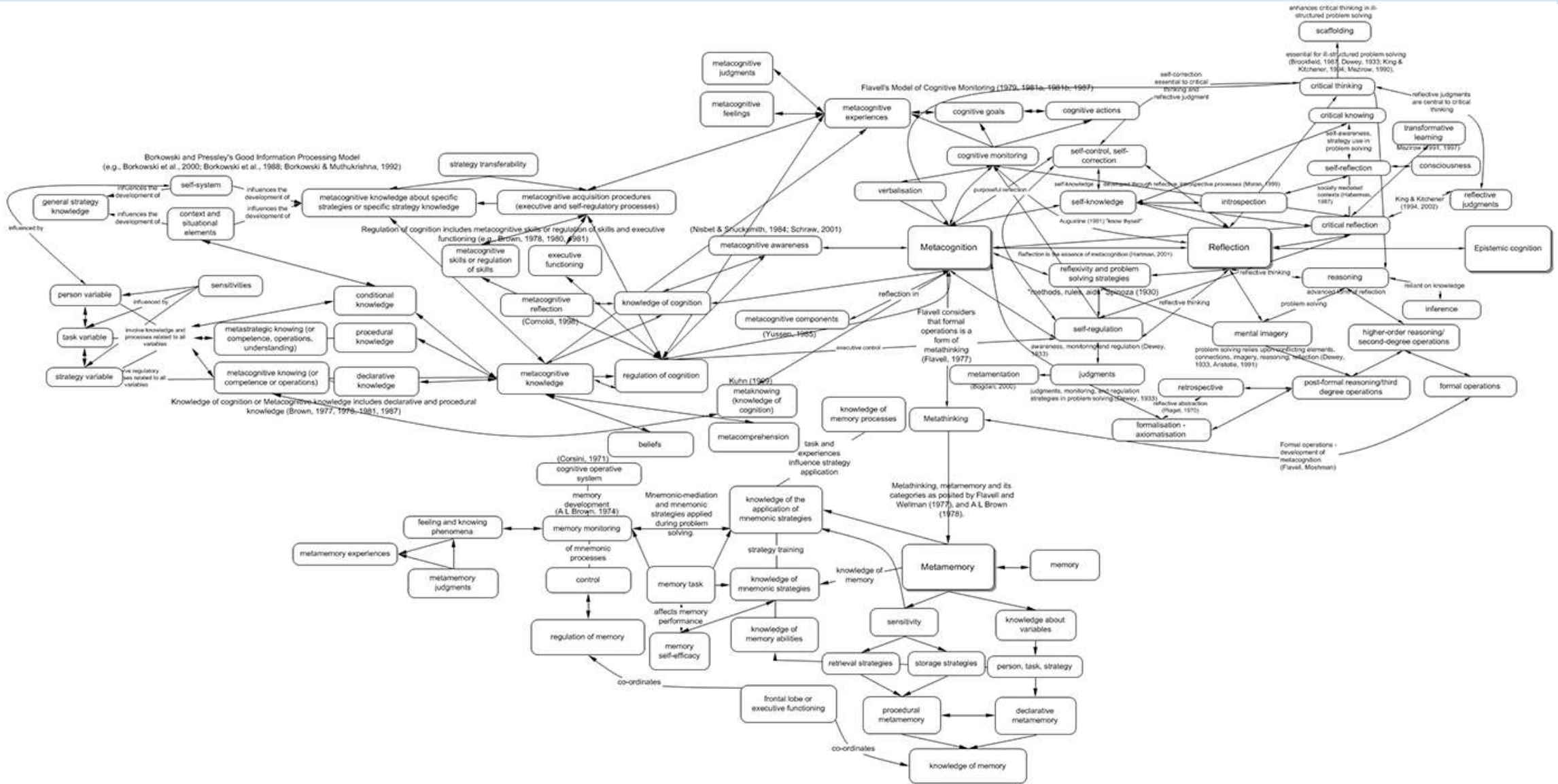
Photograph by Alain Herzog, 2015; from Joana Stella Kompa | Digital Education & Social Change blog (joanakompa.com)

Goal: Metacognition assessment

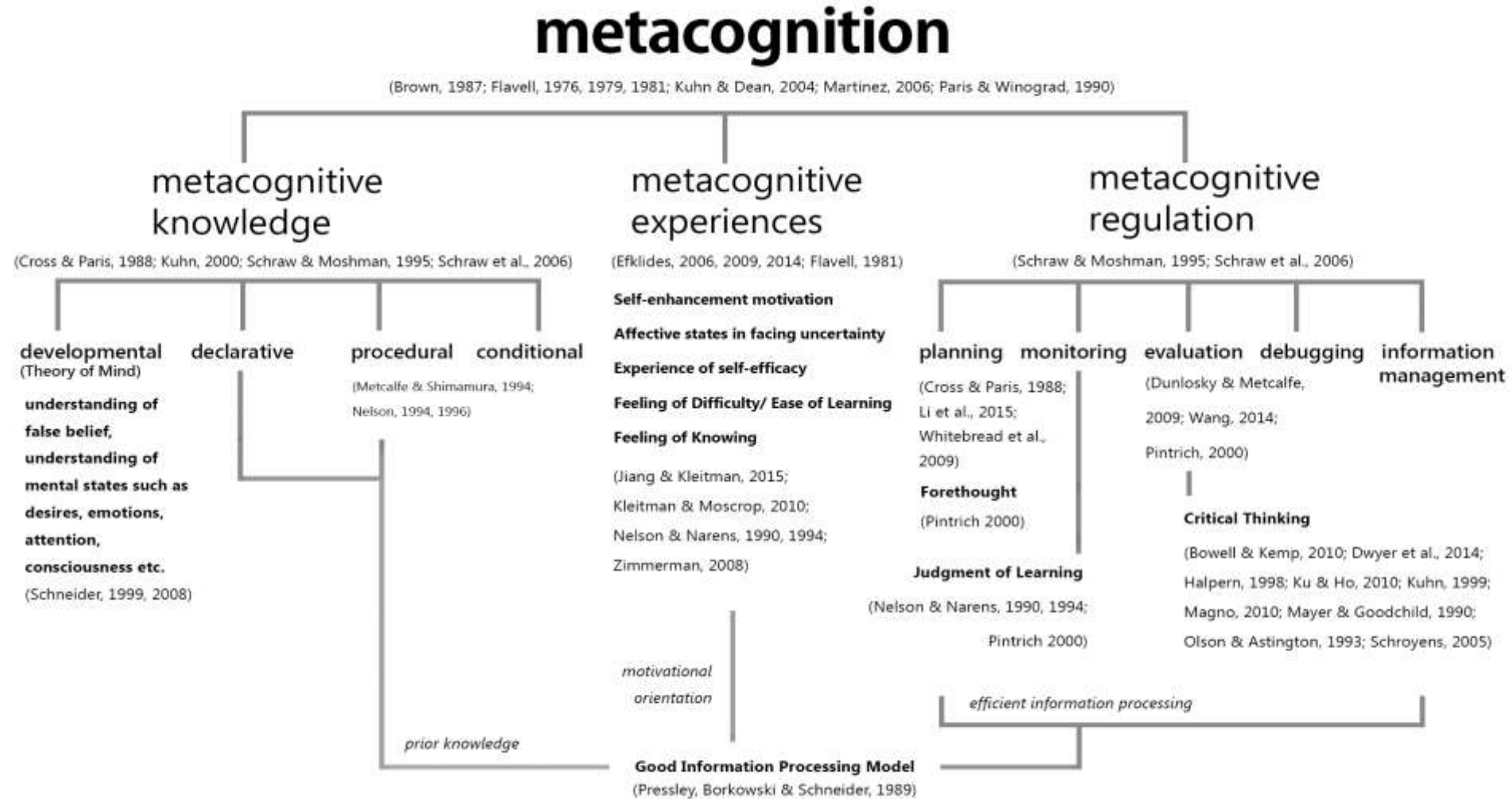
Challenges:

- (a) metacognition is a **complex** construct;
- (b) it is **not directly observable**;
- (c) it may be **confounded with** both verbal ability and working memory capacity;
and
- (d) existing measures tend to be **narrow in focus** and decontextualized from
educational and clinical psychology

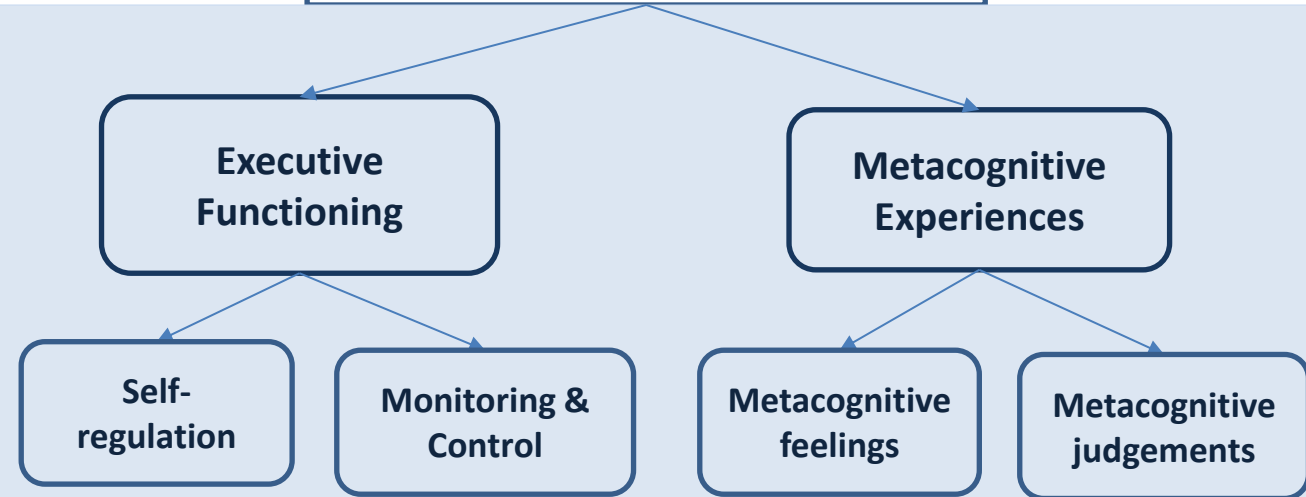
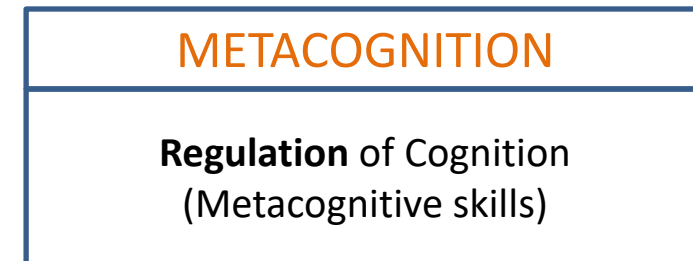
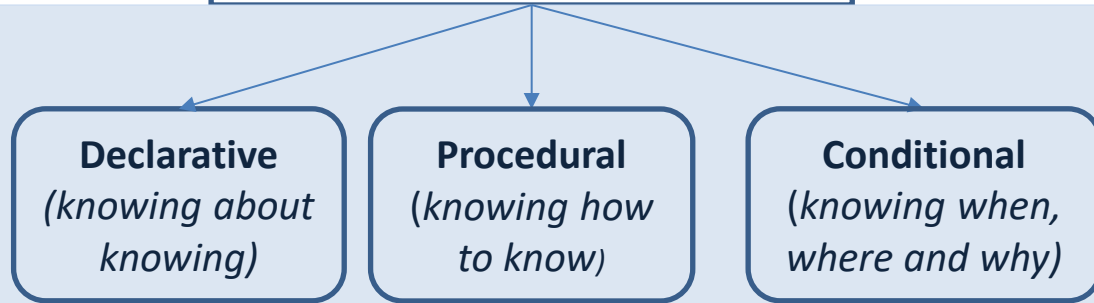
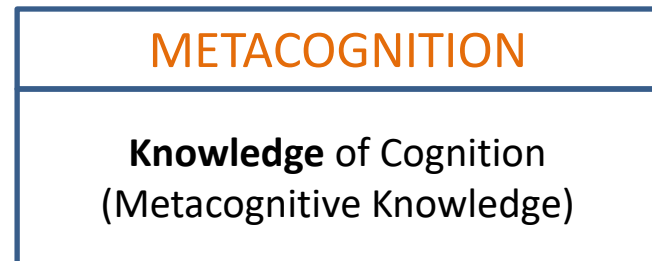
Metacognition | conceptual overview (Pina Tarricone, 2011)



Metacognition | conceptual overview



Taxonomy of Metacognition



Factors/variables

Self and others (**Person**):

- Reflective awareness
- Self-system

Task and Context:

- Task objectives/goals
- Task complexity (demands)
- Task beliefs and motivation
- Beliefs about situation

Strategy:

- Selection
- Application
- Adaptation
- Transfer

Metacognition | accessibility

Explicit and **implicit** forms of metacognition

- self-reporting
- think aloud and prompting
- explicit (multimodal) evidence of reflexive actions
- inferred from observable dialogue behaviour

Metacognition | overlapping constructs

Theory of Mind (Premack & Woodruff, 1978) - cognitive abilities to attribute mental and emotional states to self and others (beliefs, intents, desires, emotions, and knowledge)

Perspective-taking (Galinsky et al., 2008) - the ability to look beyond your own point of view, so that you can consider how someone else may think or feel about something.

Cognitive load (Sweller, 1994) - amount of cognitive thinking that is required for the activity (*intrinsic cognitive load*), the load needed for the processing, construction and automation of schemas (*germane load*) and the amount of load needed for processing external information (*extraneous cognitive load*)

Flow experience (Csikszentmihalyi, 1999) - the state of total involvement in an activity that requires complete concentration

Introduction | objectives (refined)

An elaborate computational model of (meta)cognitive states accounting for

- **Tasks** complexities and demands
- **Activities** and **strategies** (sequences, timing, frequencies, context)
- **Participants'** stable and evolving (dynamic) **dispositions**, e.g. personality, (meta)cognitive, motivational and social profiles/traits
- possibly other related concepts and **overlapping constructs**

Instruments to assess metacognition

- typology of **metacognitive events**
- big samples of **multimodal data** and **methods** to interpret it

Metacognition assessment | instruments

Self-reporting: questionnaires

- Keyword searches performed by Craig et al. (2020) located 24,396 articles from 1982 through 2018 articles evaluating metacognition through self-report
- Many questionnaires: **Metacognitive Awareness Inventory (MAI)**, Metacognition in Multiple Contexts Inventory (MMCI), Metacognitive Skills Scale (MSS), Metacognition Self-Assessment Scale (MSAS), Metacognition Scale (MS), **Metacognition Questionnaire (MCQ)**

Drawbacks:

- None fitting our purposes 100%, require adaptation
- Subjective judgements are inaccurate

Metacognition assessment | instruments

- **Verbalizing** metacognition:
 - Verbal Protocol Analysis
 - Think-aloud
 - Prompting
- **Psycho-physiological** measurements: heart rate, EEG and pupil dilation
- **Monitoring** metacognition: log files analysis, tracking, affective cognitive state recognition

Metacognition assessment | instruments

- **Interaction-based** assessment
 - *close* to **Metacognition Assessment Scale (MAS)** evaluates metacognitive function from narratives and interviews applying coherence and discourse analysis
 - multimodal interaction analysis

needed

- multi-method approach using both on-line and off-line tasks
- taxonomy of metacognitive events
- guidelines and trained annotators

DIT/ISO 24617-2 based modelling

A **metacognitive event** is characterised through evidence of reflexive activities indicating any level of sender's mindful awareness about own (sender's) and others (partner's) cognitive process(-es):

Level 0: ignore or offer false continuation;

Level 1: pay and secure attention (mutual eye contact);

Level 2: recognise, record change and respond with minimal signals, check out and verify recognition;

Level 3: interpret, check out and verify understanding, and respond to content and feeling;

Level 4: evaluate content and feeling, inspect/compare past experiences and verify hypotheses ;

Level 5: regulate and align, correct/adjust, imitate, anticipate consequences, plan the ongoing procedure .

Aspects of **information processing** that monitors, interprets, evaluates and regulates the contents and processes of its organization (Good Information Processing Model, Presley et al., 1989) → **Feedback levels:** attention, recognition, interpretation, evaluation and execution, see Allwood et al. (1993), Clark (1996) and Bunt (2000)

DIT/ISO 24617-2 based modelling

Metacognition Assessment Scale (MAS) defines 3 key dimensions:

Understanding One's Own Mind (=Auto-Feedback)	Understanding Others' Mind (=Allo-Feedback)	Mastery (= Execution Level & Interaction Control Dimensions)
Basic requirements (acknowledge)	Basic requirements (acknowledge)	Basic requirements (define)
Identification (recognize)	Identification (recognize)	1 st level strategies (seek pleasure & avoid risks)
Relating variables (construct representations, interpret)	Relating variables (construct representations, interpret)	2 nd level strategies (modify attention, understanding and evaluation)
Differentiation (recognize influences, put in context)	Differentiation (recognize influences, put in context)	3 rd level strategies (regulate & adaptation)
Integration (complete description of mental state)	Integration (complete description of mental state)	
	Decentration (not at the centre of thoughts/feelings of others)	

Taxonomy | metacognitive events | tentative mapping

Metacognitive activity	MCQ dimension	Dialogue Act			Indicator (example)
		dimension	Com. function	qualifier	
Awareness	Cognitive (self-) conciseness	Auto/Allo-Feedback	attention	(dis)engagement responsiveness	nonverbal: gaze, head orientation
			perception		verbal: backchannels
		Contact Man.	check		GUI: no activity
			indication		vocal: throat clearing
					nonverbal: leaning forward
Monitoring	Cognitive confidence	Auto/Allo-Feedback	interpretation	interest confusion uncertainty	nonverbal: eye contact
			nonverbal: puzzled look		
		Time Management	stalling		verbal: filled pauses
		Own Communication Man.	retraction		speech/GUI: slowing down
					verbal/speech: editing expressions
					speech: disfluencies
					all: false/re- starts

- **Negotiations:** high vs low self-/other-monitors and –assessors
- **Medical professionals training** for shared decision making
- **Simulations and role-playing**
 - Observing interaction and flag problems/successes
 - Think aloud and prompting protocols
 - Free flow interaction

Self-assessment tests prior to collections

Design | scenario | example

Medicines

DOCTOR	PATIENT
<input type="radio"/> Herbal and natural therapies	<input type="radio"/> Herbal and natural therapies
<input type="radio"/> Artificial pancreas	<input type="radio"/> Artificial pancreas
<input type="radio"/> Drugs	<input type="radio"/> Drugs
<input type="radio"/> Bariatric surgery	<input type="radio"/> Bariatric surgery
Conflicting preferences	

Activity

DOCTOR	PATIENT
<input type="radio"/> 2.5 h/week of moderate intensity	<input type="radio"/> 2.5 h/week of moderate intensity
<input type="radio"/> 1.5 h/week of high intensity	<input type="radio"/> 1.5 h/week of high intensity
<input type="radio"/> 20 min/week of moderate intensity	<input type="radio"/> 20 min/week of moderate intensity
<input type="radio"/> 10 min/week of moderate intensity	<input type="radio"/> 10 min/week of moderate intensity
Overlapping preferences	

Diet

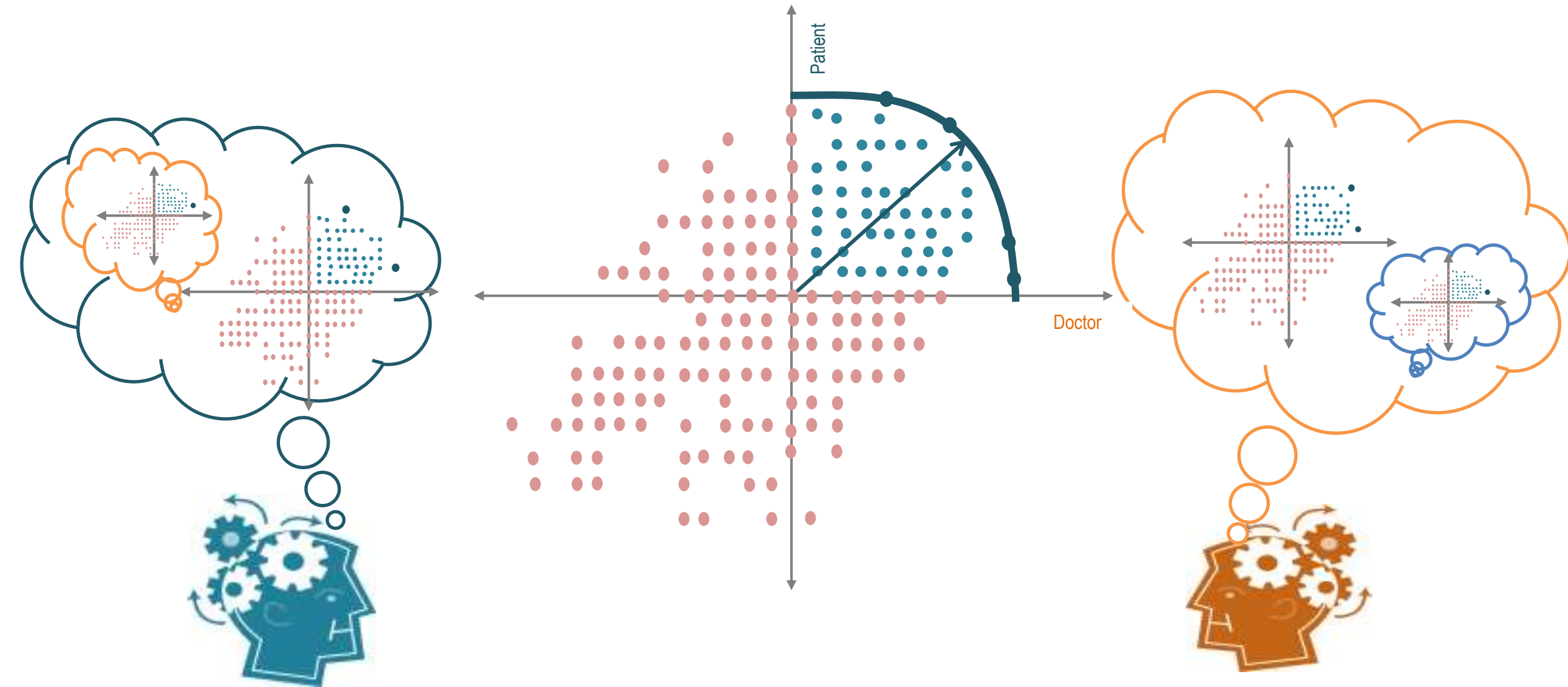
DOCTOR	PATIENT
<input type="radio"/> No smoke	<input type="radio"/> No smoke
<input type="radio"/> No alcohol	<input type="radio"/> No alcohol
<input type="radio"/> Reduce saturated fat intake	<input type="radio"/> Reduce saturated fat intake
<input type="radio"/> Lean meat, skinless chicken and turkey	<input type="radio"/> Lean meat, skinless chicken and turkey
Matching preferences	

Exercise

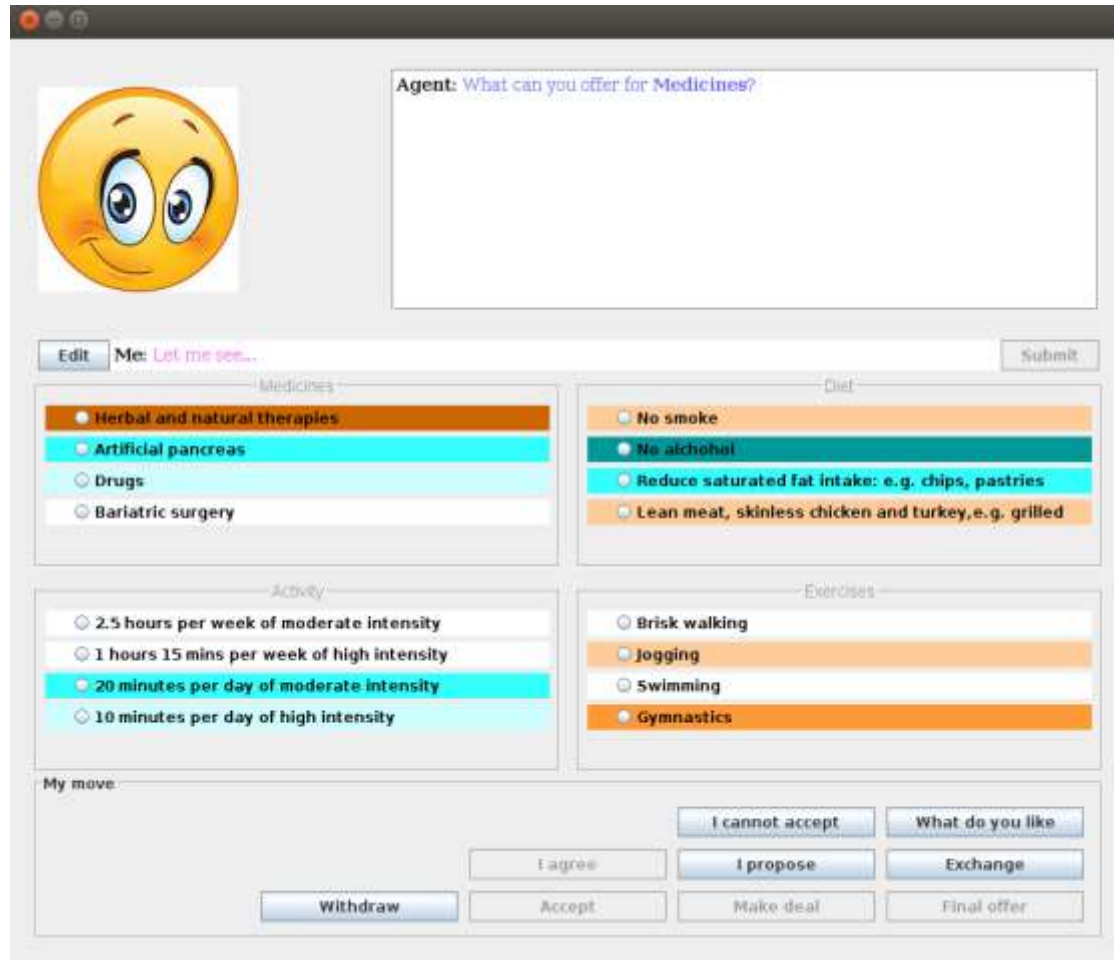
DOCTOR	PATIENT
<input type="radio"/> Brisk walking	<input type="radio"/> Brisk walking
<input type="radio"/> Jogging	<input type="radio"/> Jogging
<input type="radio"/> Swimming	<input type="radio"/> Swimming
<input type="radio"/> Gymnastics	<input type="radio"/> Gymnastics
Identical preferences	

- Quit smoking
- Diabetes Type II
- Hypertension treatment
- Obesity treatment

Metacognition | exploring negotiation space



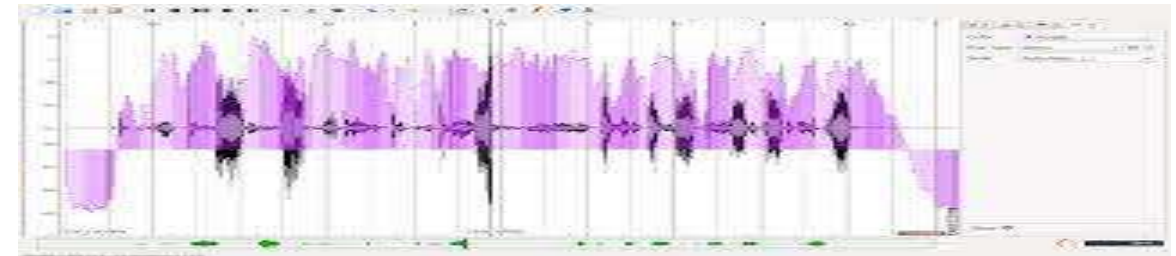
Design | data processing | interface



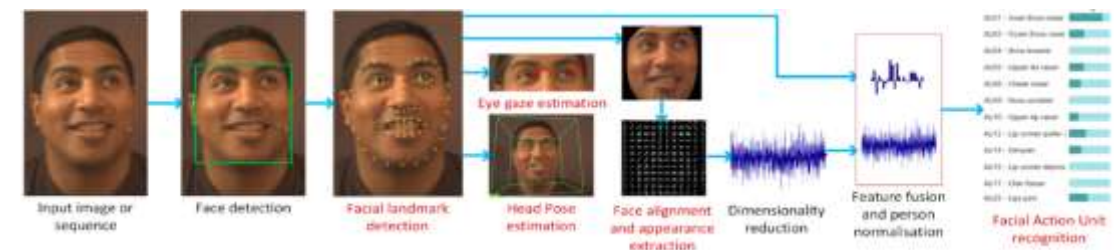
- GUI actions tracking and logging



- OpenSmile



- OpenFace



Expected outcomes

- Better understanding of metacognitive processes in dialogue → elaborate computational model
- ISO-compliant taxonomy of metacognitive events
- Set of multimodal feature extraction and classification models
- Novel tools for multidimensional dialogue analysis
- Substantial amount of multimodal data; DialogBank release

Thank You!



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