

COMPUTATIONAL PSYCHIATRY COURSE 2025

Autism

BENEFITS OF COMPUTATIONAL THEORIES FOR CLINICAL PRACTICE

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DIAGNOSTIC CRITERIA ICD-10

CHAPTER: PERVERSIVE DEVELOPMENTAL DISORDERS

EARLY CHILDHOOD AUTISM

- LIFELONG CONDITION (SINCE EARLY CHILDHOOD) :
- QUALITATIVE IMPAIRMENT OF SOCIAL INTERACTION
- " " OF COMMUNICATION (VERBAL / NONVERBAL)
- RESTRICTED REPETITIVE PATTERNS OF BEHAVIOR
- OFTEN ASSOCIATED WITH INTELLECTUAL DISABILITY
- WITHOUT GENERALIZED DEVELOPMENTAL IMPAIRMENT (LANGUAGE / IQ)

ASPERGER SYNDROME

ICD-11:

AUTISMUS SPECTRUM DISORDER

Case 1 : Johanna, 14

GOOD STUDENT BUT SOCIAL PROBLEMS DEPRESSED DUE TO SOCIAL ISOLATION

INABILITY TO INTEGRATE IN GROUPS NO SHARED INTERESTS (e.g. SOCIAL LIFE OF INSECTS)

COMMUNICATION STYLE: MONOLOGUE, NOT INTERESTED IN DIALOGUE INITIATED BY OTHERS

- ALWAYS IRRITABLE CHILD
ADAPTATION PROBLEMS (EATING, SLEEPING,
SPATIAL CHANGES)
- HIGH NEED FOR EXTERNAL STABILITY
TO REGULATE HERSELF
→ WORKS IN HOME WITH LOVING PARENTS
NOT WITH TEENAGED SCHOOLMATES
QUICKLY OVERSTIMULATED IN SCHOOL (BREAKS)

DIAGNOSTIC CRITERIA ICD-10

- ✓ LIFELONG CONDITION
 - ✓ SOCIAL INTERACTION
 - ✓ COMMUNICATION
(VERBAL/NONVERBAL)
 - ✓ RESTRICTED REPETITIVE
BEHAVIOR
- ↳ ASPERGER-SYNDROME

Johanna, 14 : INNER WORLD / SYMPTOMS

- PERCEPTION
HIGHLY PRECISE, GREAT ATTENTION TO DETAILS
EASILY CONFUSED BY SLIGHT VARIATIONS
- INTERESTS
DEEP INTERESTS FOR CHANGING SUBJECTS, EXPERT KNOWLEDGE
IN SMALL AREAS, DIFFICULTIES TO SEE CONNECTIONS/CONTEXT
- BEHAVIOUR
STRESS IN UNKNOWN CONTEXTS: AVOIDANCE
PLEASURE IN WELL-KOWN OR RULE-BASED CONTEXTS: REPETITION
- SOCIAL INTERACTION
INTERESTED IN THE "HUMAN ANIMAL", LOVES TO "STUDY" IT:
DISINHIBITED IN ASKING INDISCREET QUESTIONS
- COMMUNICATION
MONOLOGUING WITHOUT EYE CONTACT
LONG CONVERSATIONS WITH NEIGHBOUR (83)
WHEN EYE-CONTACT: "SERIOUS RESEARCHER" GAZE

COMPUTATIONAL PSYCHIATRY

THE BAYESIAN BRAIN-
THEORY OF AUTISM

OFFERS A THEORETICAL EXPLANATION

of autistic symptoms

BAYESIAN BRAIN

GENERATIVE MODEL



ENVIRONMENT

HIDDEN CAUSE



SENSORY DATA

EXPECTATION

top down

PERCEPTION

bottom up



UPDATE

SENSATION

BAYESIAN BRAIN

BAYES' THEOREM

GENERATIVE MODEL [m]

$p(x|m)$ PRIOR BELIEF

EXPECTATION

THE MOST PROBABLE CAUSE
BEFORE SEEING THE DATA

$p(x|y,m)$ POSTERIOR BELIEF

PERCEPTION

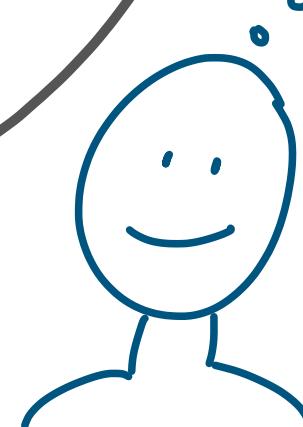
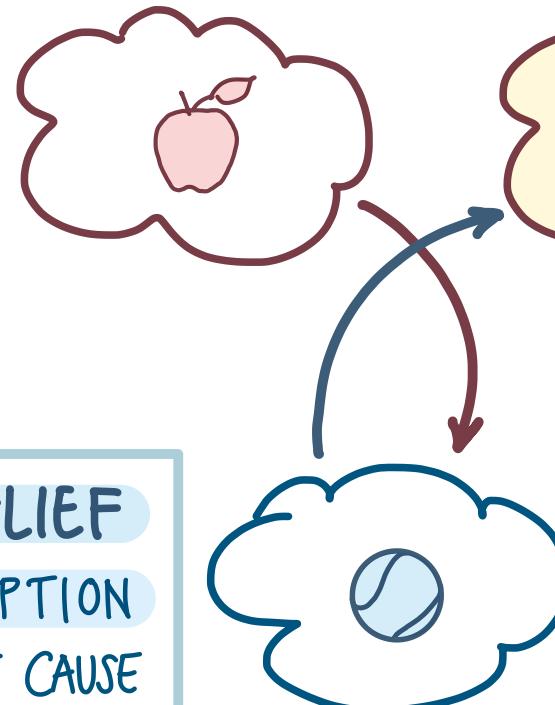
THE MOST PROBABLE CAUSE
AFTER OBSERVING THE NEW DATA

HIDDEN CAUSE

[x]



[y]



$$p(x|y,m) \sim p(y|x,m) \cdot p(x|m)$$

OPTIMIZED
MODEL :

POSTERIOR BECOMES NEW PRIOR.
MINIMIZING SURPRISE
REDUCTION OF FREE ENERGY

LIKELIHOOD $p(y|x,m)$

SENSATION

THE PROBABILITY OF THE DATA,
GIVEN A PARTICULAR CAUSE

GOAL:

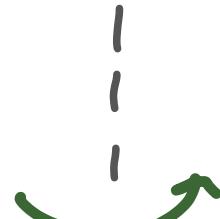
HOMEOSTASIS

OBSERVATION

CONFIRMS THE MODEL

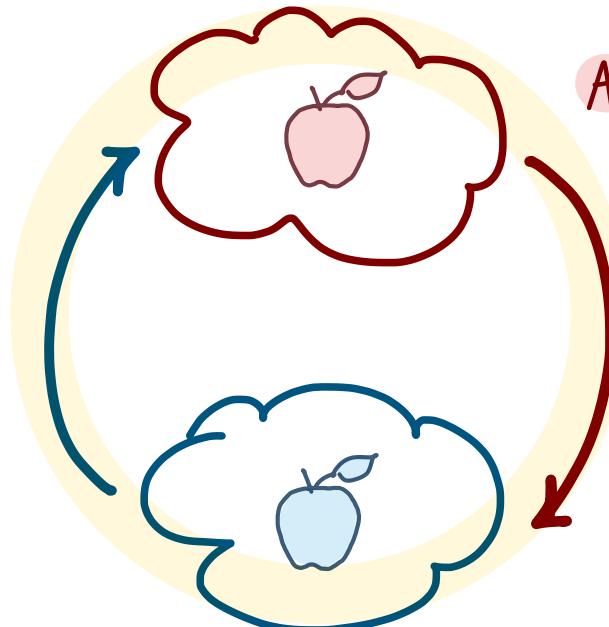


THE TRUE STATE
OF THE WORLD



SENSORY DATA

MENTAL MODEL



ACCURATE EXPECTATION
(AND TRUE STATE OF THE WORLD)



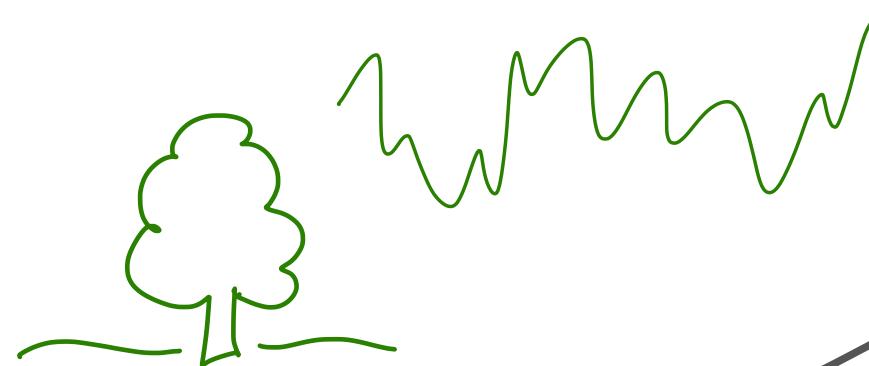
→ feeling oriented and prepared

HOMEOSTASIS

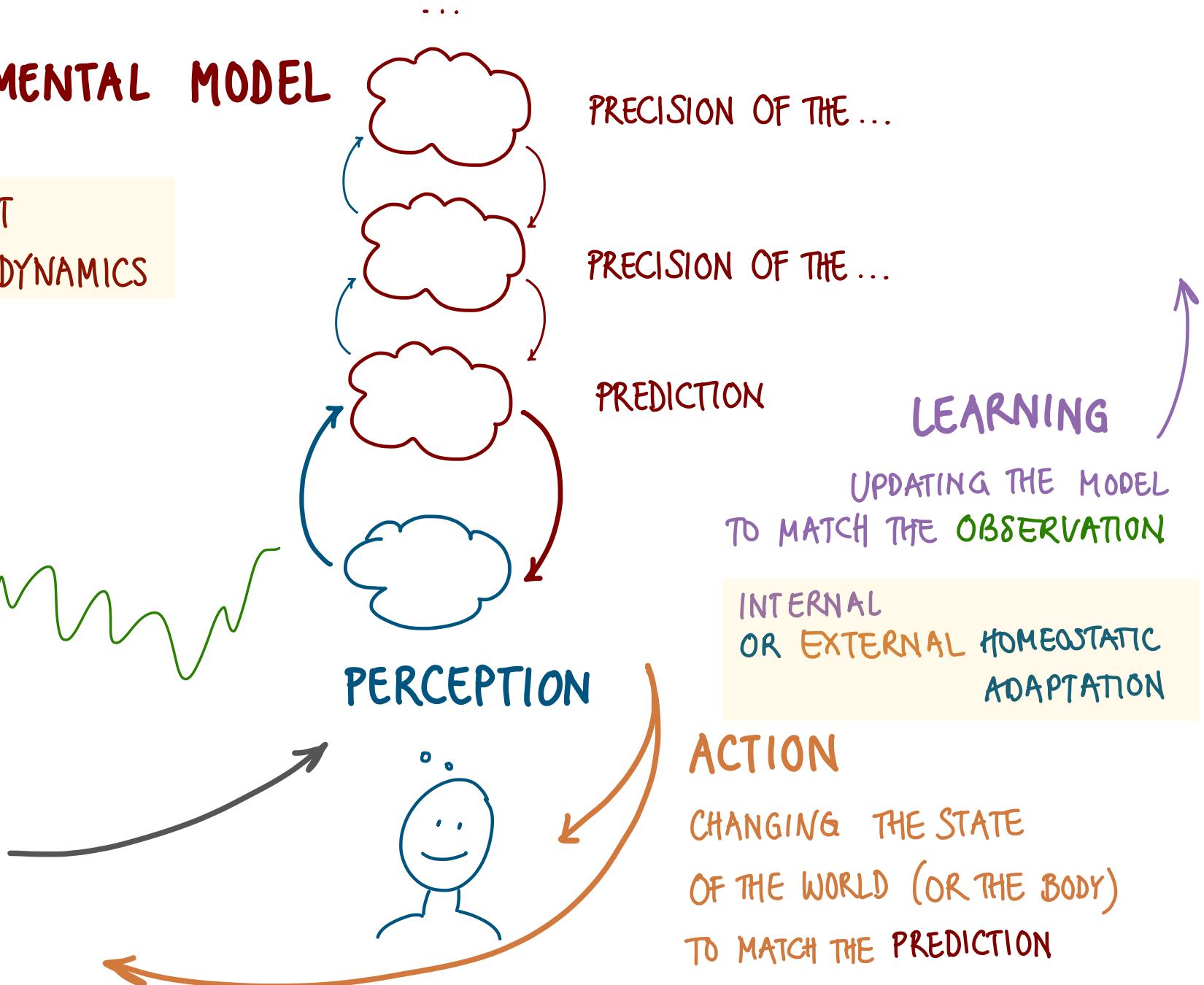
BEYOND THE HERE & NOW

HIERARCHICAL MENTAL MODEL

EXPECTATIONS ABOUT
TEMPORAL/SPATIAL DYNAMICS
OF OBSERVED STATES



THE TRUE STATE
OF THE WORLD



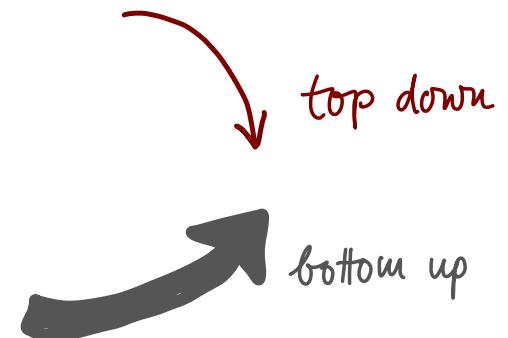
THE BAYESIAN BRAIN-THEORY OF AUTISM

AUTISM: CONGENITAL DISORDER OF INFORMATION INTEGRATION

DYSBALANCED INTEGRATION

OF BOTTOM UP INPUT AND TOP DOWN PREDICTIONS:

RELATIVE OVERWEIGHTING OF SENSORY INFORMATION



Opinion

When the world becomes 'too real': a Bayesian explanation of autistic perception

Elizabeth Pellicano^{1,3} and David Burr^{2,3}

¹Centre for Research in Autism and Education (CRAE), Institute of Education, University of London, London, UK

²Department of Psychology, University of Florence, Florence, Italy

³School of Psychology, University of Western Australia, Perth, Australia

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Cell
PRESS

frontiers
in Psychiatry

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Can Bayesian Theories of Autism Spectrum Disorder Help Improve Clinical Practice?

Helene Haker^{1*}, Maya Schneebeli¹ and Klaas Enno Stephan^{1,2,3}

¹Translational Neuromodeling Unit (TNU), Institute for Biomedical Engineering, University of Zurich and ETH Zurich, Zurich, Switzerland, ²Wellcome Trust Centre for Neuroimaging, University College London, London, UK, ³Max Planck Institute for Metabolism Research, Cologne, Germany

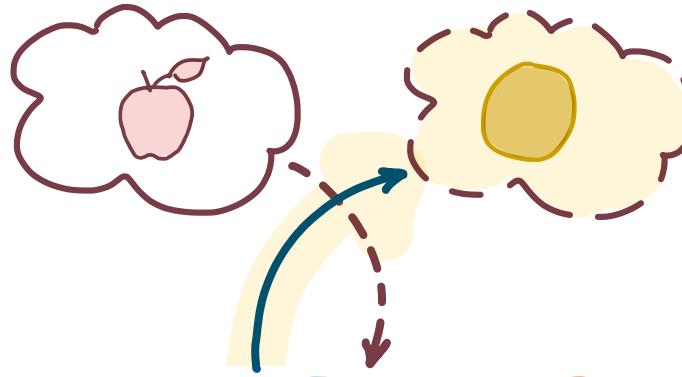
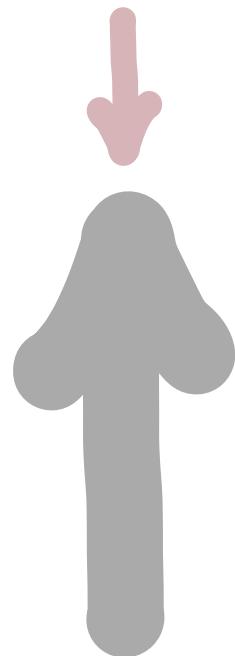
DYSBALANCE

RELATIVE OVERWEIGHTING OF SENSORY DATA

ineffective attenuation
of prediction errors

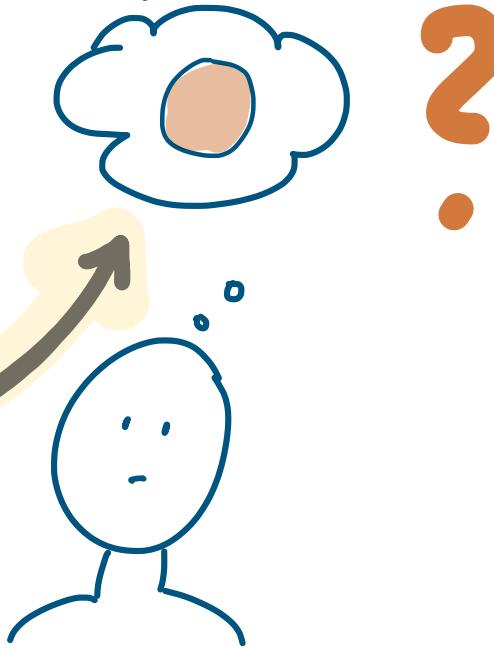
PREDICTION
relatively weak

top down



... overfitting

PERCEPTION
close to...
SENSORY DATA
relatively strong



bottom up

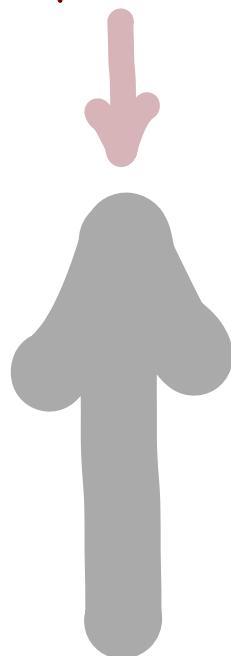
sensory overload

difficult attribution
of meaning

DYSBALANCE

ineffective attenuation
of prediction errors

top down



bottom up

sensory overload

PREDICTION

relatively weak

overfitting

PERCEPTION
close to...

SENSORY DATA
relatively strong



\\\\,
- STRESS! -
\\\\, \\\\,

DESORIENTATION

CONSTANT SURPRISE
DESTABILISES
HIGHER LEVELS

consequence:

CHRONIC DYSHOMEOSTASIS

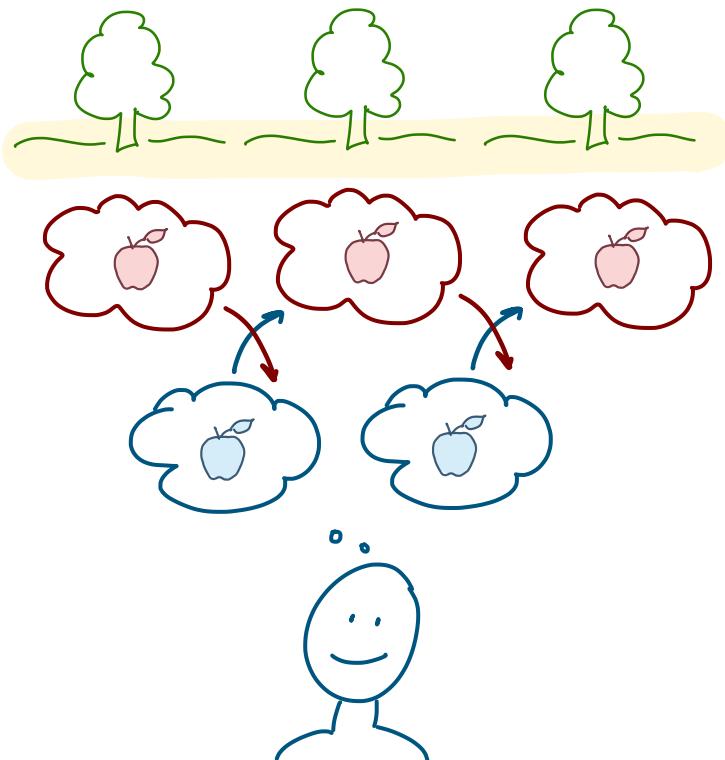
the world appears
fragmented, meaningless
and highly unstable

COPING STRATEGY

HOMEOSTATIC ADAPTATION:

REDUCTION OF SURPRISE

THROUGH EXTERNAL STABILISATION



- PERCEPTION

SYMPTOMS

CLOSE TO SENSORY INPUT: FOCUS ON SMALL DETAILS

LACK OF COHERENCE, OVERVIEW OR ABSTRACTION

IRRITABILITY BY SMALL VARIATIONS

- INTERESTS

FOCUS ON HIGHLY STRUCTURED, RULE-BASED AREAS
DEEP DIVES (MORE OF THE SAME)

- BEHAVIOUR

RESTRICTION AND REPETITION
AS MEANS OF STABILISATION

- SOCIAL INTERACTION/COMMUNICATION

COMPLEX DYNAMIC PROCESSES

LOADED BY IRRELEVANT, RANDOM FEATURES

HIGH LEVELS OF ABSTRACTION NEEDED FOR DECODING

BUT RESP. MODEL-LEVELS UNDERDEVELOPED

DEVELOPMENT: Johanna, 32

- ARCHITECT ("THE IMPACT OF SPATIAL DESIGN ON MENTAL WELLBEING")
- HAPPILY MARRIED TO AND WORKING WITH ANOTHER ARCHITECT
HIGHLY STRUCTURED DAILY LIFE WITH LITTLE VARIATIONS OR SURPRISES
- HANDFULL CLOSE FRIENDS WITH SHARED INTERESTS
- LOVED BY THE CIRCLE OF FRIENDS OF HER HUSBAND
AND HIGHLY RESPECTED BY THEIR CLIENTS
AS A BRIGHT MIND AND EXCEPTIONAL QUESTION ASKER
- EASILY EXHAUSTED AND EMOTIONALLY DYSBALANCED
IF OUTSIDE OF KNOWN ROUTINES

COMPUTATIONAL PSYCHIATRY

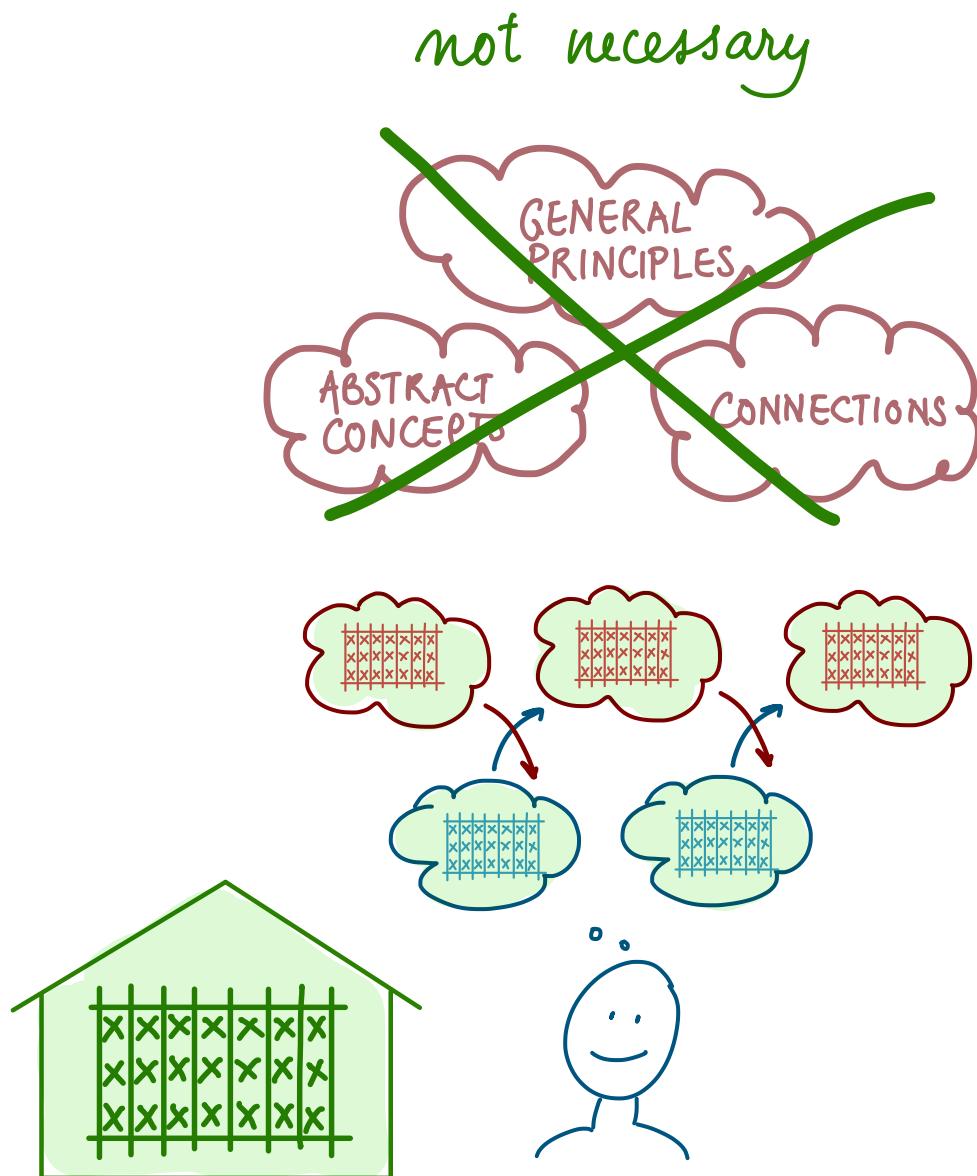
THE BAYESIAN BRAIN-
THEORY OF AUTISM

OFFERS A THEORETICAL EXPLANATION

of autistic development

BEHAVIOURAL COPING:

STRESS REGULATION



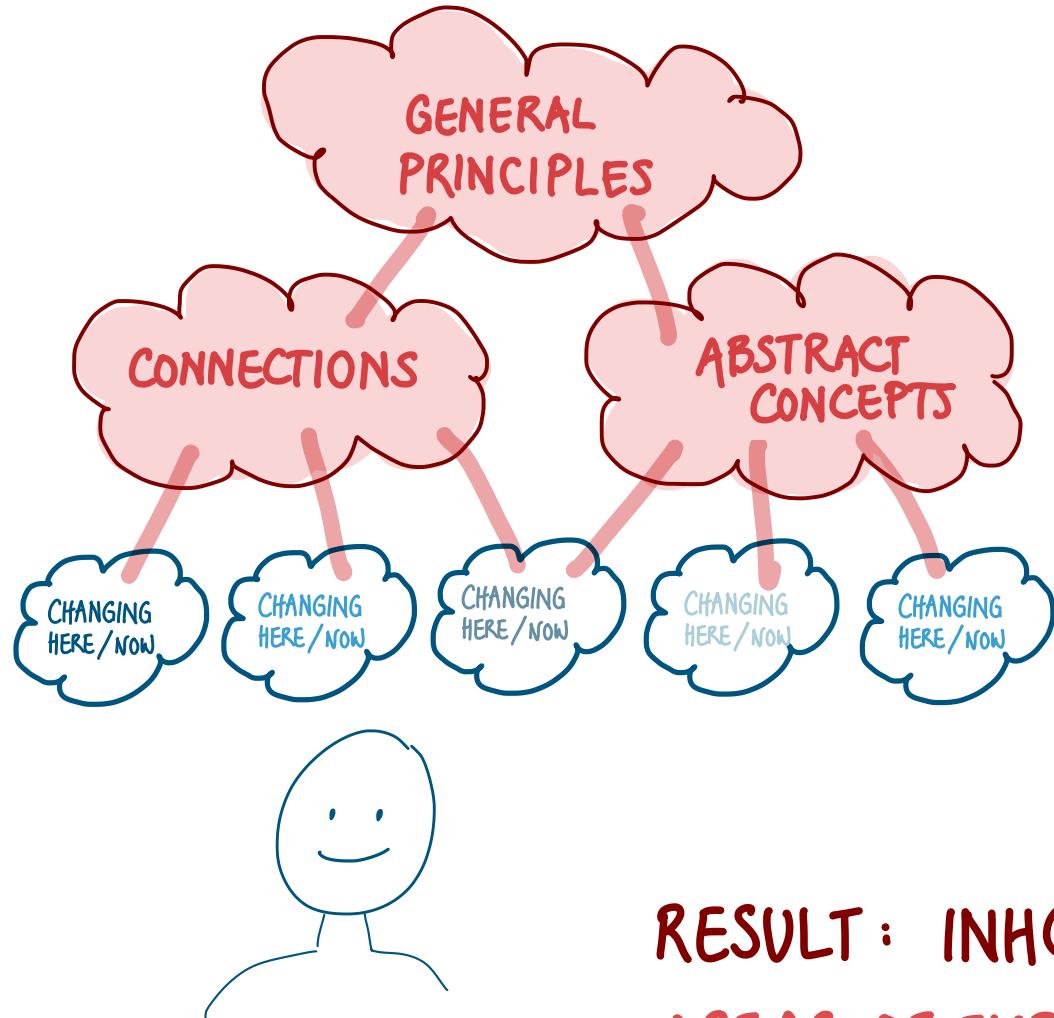
RESTRICTED, REPETITIVE, AND INFLEXIBLE
~ STABILISING BEHAVIOUR

REDUCTION OF COMPLEXITY AND DYNAMICS
THROUGH STRUCTURING OF SPACE AND TIME

DISADVANTAGE

- NARROWS THE SCOPE OF ACTION
- HINDERS THE DEVELOPMENT
- "AUTISTIC"

COGNITIVE COPING: MATURATION OF THE MENTAL MODEL



CONSTRUCTION OF CONNECTIONS

- THROUGH ACTIVE, CONSCIOUS REFLEXION
- OR EXPLICITE INSTRUCTION

LIMITATIONS:

- RESSOURCE-INTENSIVE
- ERROR-PRONE (- PSYCHOSIS)
- INFLEXIBLE

RESULT: INHOMOGENOUS!

AREAS OF EXPERTISE CONTRASTING
WITH AREAS OF GREAT NAÏVETY

FACTORS INFLUENCING DEVELOPMENT

INDIVIDUALS

- CURIOSITY
- MOTIVATION
- ENERGY
- TIME
- INTELLIGENCE
- COMORBIDITY
- TEMPERAMENT
- PERSONALITY

STRENGTH TO FACE
THE CHAOS

ENVIRONMENT

- PREDICTABILITY

TEMPORAL / SPATIAL

- STRUCTURE
- REGULARITY
- STABILITY
- STIMULUS DENSITY

EXTENT OF CHAOS
IN THE ENVIRONMENT

SOCIAL

- EMOTIONAL STABILITY
- EXPLICIT VERBAL AND NONVERBAL COMMUNICATION
- "SAY WHAT YOU MEAN
AND DO WHAT YOU SAY"
- INTEREST
- OPENNESS (↔)
- PATIENCE

Johanna, 32

COPING STRATEGIES

- ARCHITECT ("THE IMPACT OF SPATIAL DESIGN ON MENTAL WELLBEING")

- HAPPILY MARRIED TO AND WORKING WITH ANOTHER ARCHITECT

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- LOVED BY THE CIRCLE OF FRIENDS OF HER HUSBAND

- AND HIGHLY RESPECTED BY THEIR CLIENTS

- AS A BRIGHT MIND AND

- EXCEPTIONAL QUESTION ASKER

COGNITIVE COPING

- EASILY EXHAUSTED AND

- EMOTIONALLY DYSBALANCED

- IF OUTSIDE KNOWN ROUTINES

FRAGILE HOMEOSTATIC BALANCE

DEVELOPMENT: Johanna, 32

PROBLEM OF
ICD-10 CRITERIA
APPLIED TO ADULTS:

too narrow!

?

DIAGNOSTIC CRITERIA ICD-10

- ?
- ✗ SOCIAL INTERACTION
- ✗ COMMUNICATION
(VERBAL / NONVERBAL)
- ~~ RESTRICTED REPETITIVE
BEHAVIOR
- ↳ ASPERGER-SYNDROME ?

ICD-11 DIAGNOSTIC CRITERIA AUTISMUS SPECTRUM DISORDER (6A02)

1. DEFICITS IN SOCIAL COMMUNICATION AND RECIPROCAL SOCIAL INTERACTIONS
2. RESTRICTED, REPETITIVE, AND INFLEXIBLE PATTERNS OF BEHAVIOUR/INTERESTS/ACTIVITIES
3. ONSET DURING DEVELOPMENTAL PERIOD, TYPICALLY EARLY CHILDHOOD
4. SIGNIFICANT IMPAIRMENT IN PERSONAL, FAMILY, SOCIAL, EDUCATIONAL/OCCUPATIONAL OR OTHER IMPORTANT AREAS OF FUNCTIONING.

PRESUMPTIVE AETIOLOGY: PRIMARILY DUE TO GENETIC OR OTHER FACTORS
THAT ARE PRESENT FROM BIRTH

ICD-11 DIAGNOSTIC CRITERIA AUTISMUS SPECTRUM DISORDER (6A02)

1. DEFICITS IN SOCIAL COMMUNICATION AND RECIPROCAL SOCIAL INTERACTIONS
[error bar] MANIFESTATIONS VARY ACCORDING TO AGE, VERBAL/INTELLECTUAL ABILITY AND DISORDER SEVERITY
2. RESTRICTED, REPETITIVE, AND INFLEXIBLE PATTERNS OF BEHAVIOUR/INTERESTS/ACTIVITIES
3. ONSET DURING DEVELOPMENTAL PERIOD, TYPICALLY EARLY CHILDHOOD
[error bar] SYMPTOMS MAY NOT BECOME FULLY MANIFEST UNTIL LATER, WHEN SOCIAL DEMANDS EXCEED LIMITED CAPACITIES/COPING
4. SIGNIFICANT IMPAIRMENT IN PERSONAL, FAMILY, SOCIAL, EDUCATIONAL/OCCUPATIONAL OR OTHER IMPORTANT AREAS OF FUNCTIONING.
[error bar] SOME ARE ABLE TO FUNCTION ADEQUATELY IN MANY CONTEXTS THROUGH EXCEPTIONAL EFFORT, SUCH THAT THEIR DEFICITS MAY NOT BE APPARENT TO OTHERS.

ICD-11 DIAGNOSTIC CRITERIA AUTISMUS SPECTRUM DISORDER (6A02)

1. DEFICITS IN SOCIAL COMMUNICATION AND RECIPROCAL SOCIAL INTERACTIONS
[manifestations vary according to age, verbal/intellectual ability and disorder severity]
2. RESTRICTED, REPETITIVE, AND INFLEXIBLE PATTERNS OF BEHAVIOUR/INTERESTS/ACTIVITIES
3. ONSET DURING DEVELOPMENTAL PERIOD, TYPICALLY EARLY CHILDHOOD
[symptoms may not become fully manifest until later, when social demands exceed limited capacities/coping]
4. SIGNIFICANT IMPAIRMENT IN PERSONAL, FAMILY, SOCIAL, EDUCATIONAL/OCCUPATIONAL OR OTHER IMPORTANT AREAS OF FUNCTIONING.
[some are able to function adequately in many contexts through exceptional effort, such that their deficits may not be apparent to others.]

PROBLEM OF THE NEW CRITERIA:
lack of specificity !

Case 2 : Liz, 24

- STUDENT OF LITERATURE
- OVERWHELMED BY COPING WITH EVERY DAY LIFE → EXHAUSTED / DEPRESSED ← 4
- PROBLEMS MAINTAINING FRIENDSHIPS AND INTEGRATING IN GROUPS } ← 1
- COMMUNICATION: OVERSHARING / OVEREXPLAINING
- HIGHLY IRRITABLE BY UNCLEAR EMOTIONAL COMMUNICATION
- "BROKEN HOME", MOTHER ALCOHOL, STEP FATHER ABUSIVE } ← 3
- SEVERAL ATTEMPTS OF PSYCHOTHERAPY, NO DIAGNOSIS STATED
- SOCIAL MEDIA: AUTISM SPECTRUM DISORDER ?
 - ↓
- INSPIRATION: ROUTINES, SOCIAL WITHDRAWAL,
 - ↓ WITHDRAWAL OF STIMULATION (NC HEADPHONES, ONLINE PARTICIPATIONS...) } ← 2
- STRESS ↓ + NEW ONLINE COMMUNITY
 - DIAGNOSTIC EVALUATION

Case 2 : Liz, 24

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↓
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↓
WITHDRAWAL OF STIMULATION (NC HEADPHONES,
ONLINE PARTICIPATIONS...)
- STRESS ↓ + NEW ONLINE COMMUNITY
→ DIAGNOSTIC EVALUATION

OPEN QUESTION:

does liz suffer
from a congenital
disorder of
information
integration?

ICD-11 CRITERIA

1. SOCIAL COMMUNICATION /
SOCIAL INTERACTIONS
✓ MANIFESTATIONS VARY
2. RESTRICTED, REPETITIVE,
✓ AND INFLEXIBLE BEHAVIOUR
3. ONSET EARLY CHILDHOOD
✓ SYMPTOMS MAY NOT BECOME
FULLY MANIFEST UNTIL LATER
4. SIGNIFICANT IMPAIRMENT
✓ SOME ARE ABLE TO FUNCTION
ADEQUATELY IN MANY CONTEXTS

PRESUMPTIVE AETIOLOGY: PRIMARILY DUE TO GENETIC OR OTHER FACTORS
THAT ARE PRESENT FROM BIRTH

?



STABILISING BEHAVIOR AS ADAPTIVE STRATEGY TO DIFFERENT SCENARIOS OF PERCEIVED INSTABILITY

CASE 1

STRUCTURE OF THE MODEL

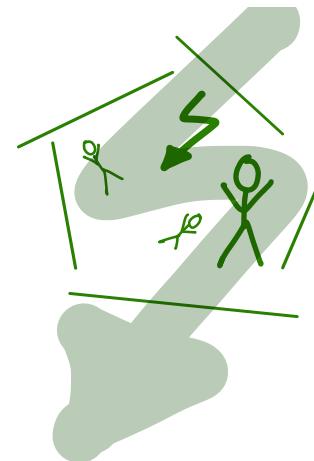


CONGENITAL DISORDER OF
INFORMATION INTEGRATION

SOURCE OF
PERCEIVED
INSTABILITY

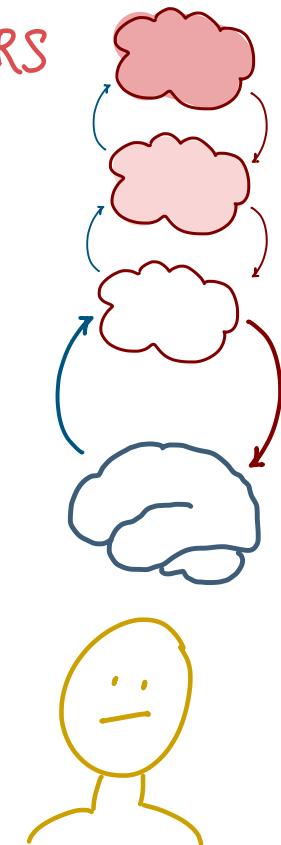
CASE 2

LEARNED PRIORS



INSTABLE CONDITIONS
IN EARLY LIFE

← CAUSE →



difficult to differentiate by mere application of the diagnostic criteria

COMPUTATIONAL PSYCHIATRY

POTENTIAL SOLUTIONS
TO THIS PROBLEM OF
DIFFERENTIAL DIAGNOSIS ?

→ OBJECTIVE DIAGNOSTIC ASSAYS
(tbd)

beyond man-made diagnostic categories

→ INTUITIVE MECHANISTIC EXPLANATIONS
OFFERING IDEAS FOR TREATMENT

helpful in clinical practice !

IDEAS FOR TREATMENT/ PROGNOSIS

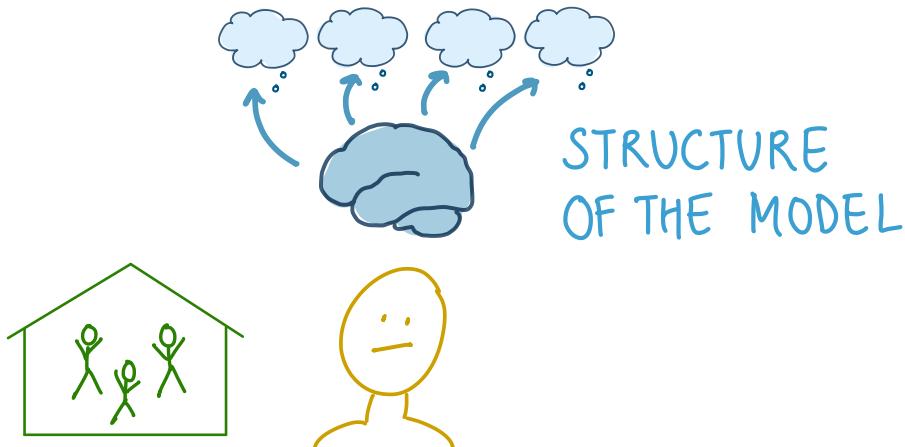
EFFORT MANAGEMENT

- OPTIMIZE EFFICIENCY WITH TEMPORAL/SPATIAL STRUCTURES

MODEL MATURATION

- RESOLVING IRRITATIONS/QUESTIONS
- BROADENING THE SCOPE OF ACTION

→ FAR-REACHING DEVELOPMENT POSSIBLE
BUT LIFELONG CHALLENGE



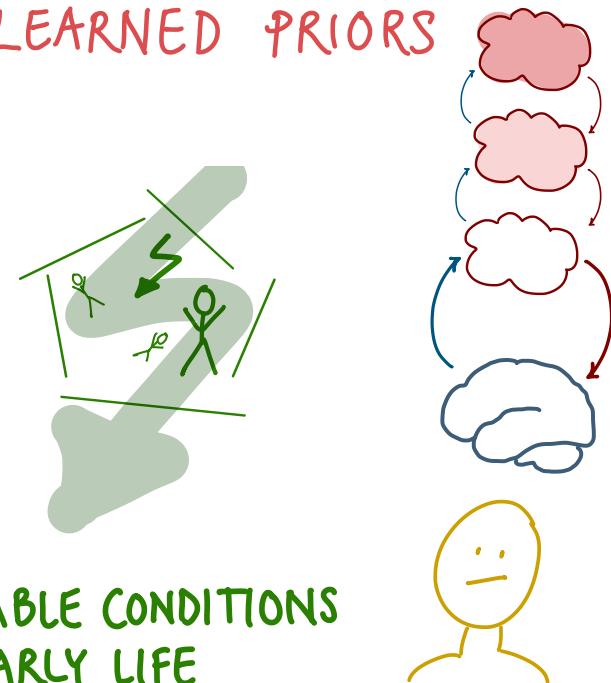
CONGENITAL DISORDER OF
INFORMATION INTEGRATION

CHANGE HIGH LEVEL PRIORS

- "CORRECTIVE" RELATIONSHIP EXPERIENCES
- TRAUMA THERAPY

→ TREATABLE: DIFFICULT,
BUT LIFELONG EFFECT

LEARNED PRIORS



take home

AUTISMUS SPECTRUM DISORDER

- IS A DEVELOPMENTAL DISORDER. PRESUMED AETIOLOGY: FACTORS PRESENT FROM BIRTH (GENETIC)
- ITS CLINICAL CONCEPT HAS EVOLVED OVER TIME
- THE CURRENT DIAGNOSTIC CRITERIA (ICD-10) LACK SPECIFICITY IN CLINICAL PRACTICE

THE BAYESIAN BRAIN-THEORY OF AUTISM

DESCRIBES AUTISM AS

CONGENITAL DISORDER OF INFORMATION INTEGRATION

DYSBALANCED INTEGRATION OF BOTTOM UP INPUT AND TOP DOWN PREDICTIONS :
RELATIVE OVERWEIGHTING OF SENSORY INFORMATION

CONSEQUENCES:

SENSORY OVERSTIMULATION , DIFFICULT MATURATION OF HIGH LEVELS OF THE MENTAL MODEL
STABILISING BEHAVIOR AND INHOMOGENEOUS MODEL MATURATION (AREAS OF EXPERTISE)