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Back to the big wide world

How to integrate voice biomarkers into clinical practice in psychiatry?

Vincent P. MARTIN

Vincent P. Martin



Ingénieur (ENSEA 2018)
Spécialisé en traitement du signal
multimédia

2019

Ingénieur de recherche
Univ. Bordeaux, LaBRI, SANPSY

2020

Doctorant en Informatique
Biomarqueurs vocaux de la somnolence
J.L. Rouas (CNRS), P. Philip (PU-PH)

2021



**DIU d'épistémologie de
la psychiatrie**
Jean-Arthur Micoulaud-Franchi



Ph.D. Informatique
Biomarqueurs vocaux de la
somnolence

2022



ATER en informatique
Biomarqueurs vocaux en
psychiatrie

2023

Audition CNRS

Section CID n°53
Production et circulation des savoirs



MSCA Postdoctoral Fellow

Bourse Marie Curie
Guy Fagherazzi

Terrain Ψ – CH Saint Antoine

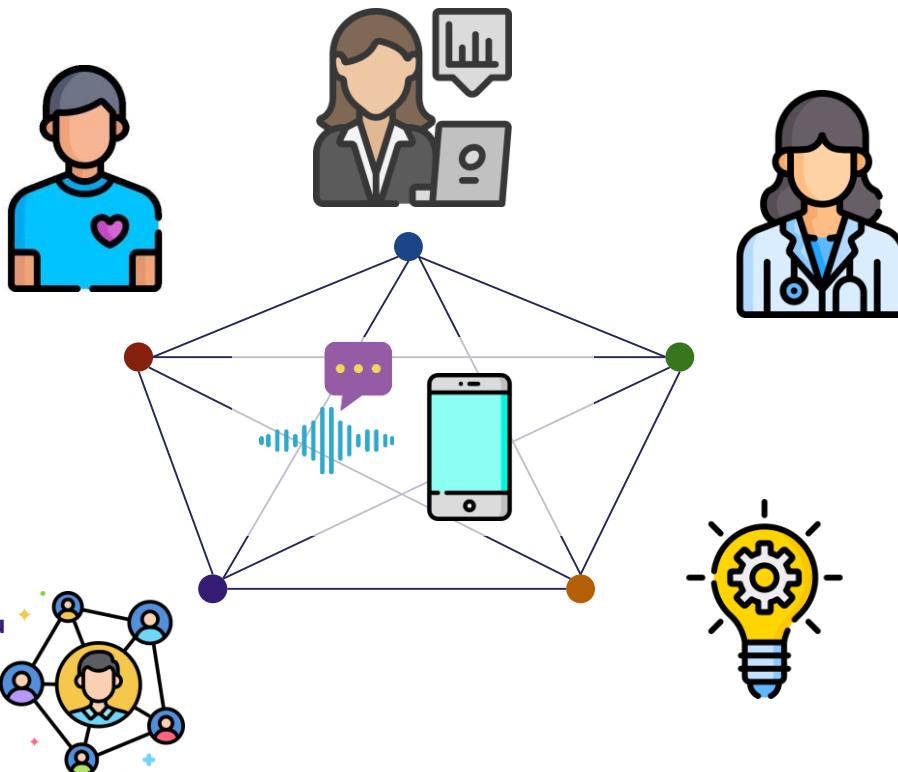
Stéphane Mouchabac
Service d'hospitalisation libre, urgences,
liaison

Conception des biomarqueurs vocaux

- Quels biomarqueurs ?
- Des **biomarqueurs de quoi** ?
- Rôle de l'**explicabilité**
- Perception des **enjeux cliniques**

Patient utilisateur

- Comment la **rencontre** avec un **ACA transforme l'utilisateur** ?
- Qu'est-ce que son utilisation dit de l'utilisateur ?
- Quel modèle **d'acceptabilité** ?



Rôle social du patient/clinicien

- Comment le passage à une « **santé** numérique » change le **rôle social du clinicien et du patient** ?
- **Performance de santé**

Terrain médical

- Quelle utilisation du **numérique** dans la pratique médicale ?
- Quels sont les différents acteurs et quel est l'impact sur chacun d'entre eux ?
- Quel accueil de ces **promesses de changements** ?

Raisonnement clinique

- Comment raisonnent les cliniciens ?
- Quelle est la place du **diagnostic** dans leurs décisions ?
- Quels **symptômes** minimaux ?

- « Les psychiatres » → intéressés par numérique
- Terrain → soins libres, urgences généralistes
- Φ de la Ψ: phénoménologie, approches critiques des neurosciences/diagnostic
- Frontière philo de terrain / socio floue

1/8 of the pop.

Mental disorder

-20 year

Life expectancy

1/3 depression

Without structured mental health care

Needs: Follow-up



Accessible



Regular



Ecological



Fatigue

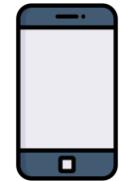
Depression

Sleepiness

...



Smartphones



80% of the
world pop.



REGULAR

ECOLOGICAL

OBJECTIVE

“Gold-standard diagnostic and assessment tools for depression and suicidality remain rooted, almost exclusively, on the **opinion of individual clinicians** risking a range of **subjective biases**. Currently there is no **objective measure**, with **clinical utility**, for either depression or suicidality”

Need for objective diagnosis

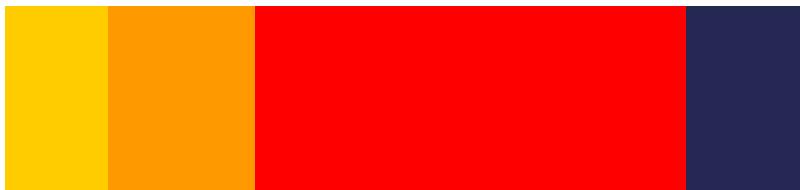
28 mhealth professionals

14,9% definitions of the diseases

21,6% patients' characteristics

63,5% clinicians' characteristics

87% diagnosis = not reliable



Need for objective diagnosis

Table 6.—Diagnoses Given to Patient F

	American Psychiatrists (N = 133)	British Psychiatrists (N = 194)
Schizophrenia	92 (69%)	4 (2%)
Simple	0	1
Catatonic	1	0
Paranoid	27	1
Latent	8	0
Residual	3	0
Schizo-affective	33	1
Unspecified	20	1
Personality Disorder	10 (8%)	146 (75%)
Paranoid	1	2
Affective (cyclothymic)	1	8
Explosive	0	2
Hysterical	4	105
Asthenic	0	2
Antisocial	1	8
Unspecified	3	19
Affective Psychosis	10 (8%)	7 (4%)
Neurosis	19 (14%)	37 (19%)
Alcoholism or Drug Dependence	2	0

Clinicians need objective assessments
of psychiatric disorders

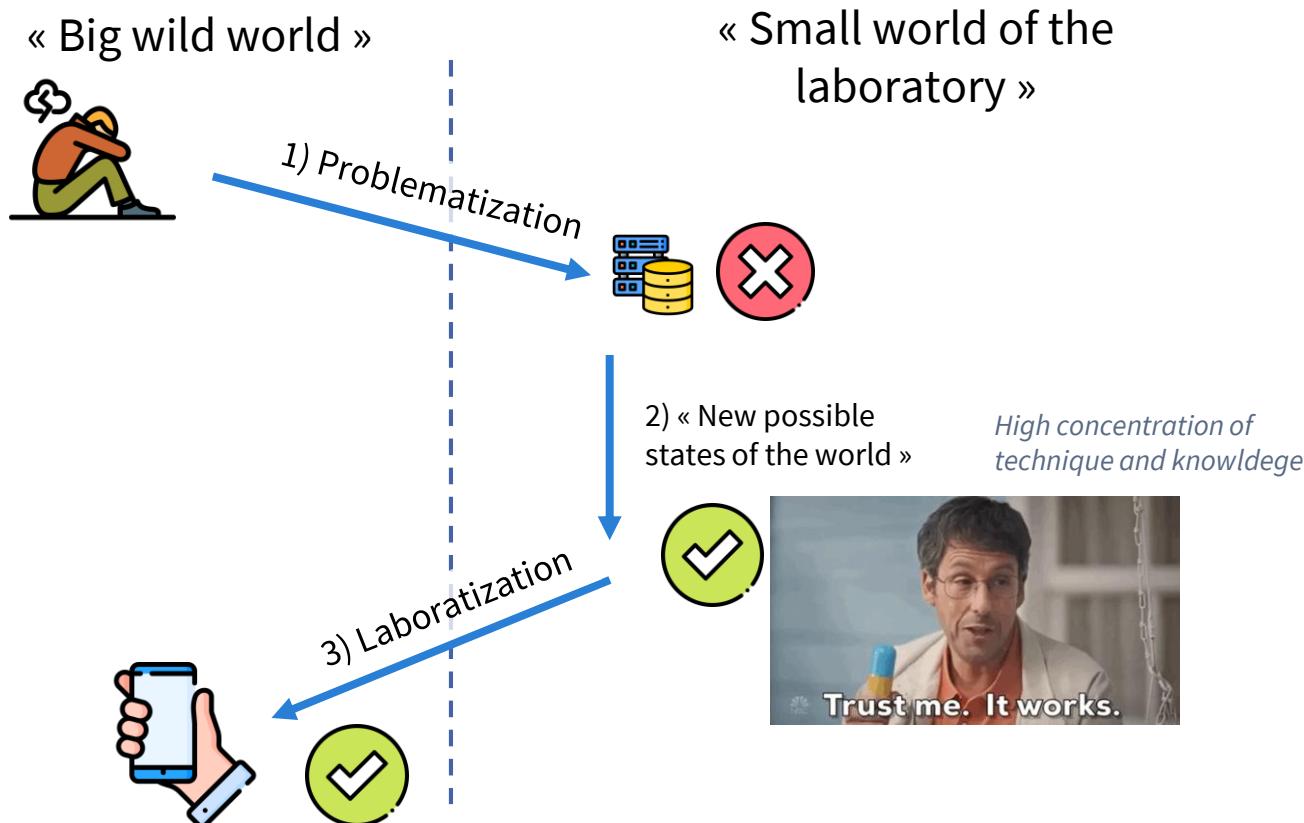
State of the art



Where are they?



Sociology of traduction



Les moutons de Sellafield

Incendie de Windscale 1957

Sellafield, BBC, 31 Octobre 1983

Tchernobyl, 21 avril 1986



« Les chercheurs croient qu'un mouton est un mouton ; les éleveurs savent bien qu'une telle tautologie est une grossière erreur [...] C'est parce que les spécialistes ne le voit pas qu'ils butent sur un obstacle qu'ils ne peuvent surmonter»

Clinicians need objective assessments
of ~~psychiatric disorders~~

Why estimating the diagnosis is a bad idea

1

Clinical practice

2

Heterogeneity

3

Unstability

'You may have depression'

'You have a 80% probability of having schizophrenia'

'You are bipolar'

Why estimating the diagnosis is a bad idea

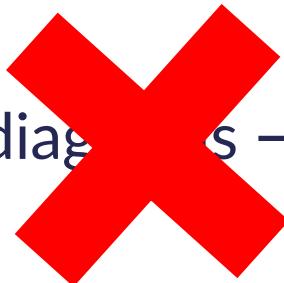


Clinical practice



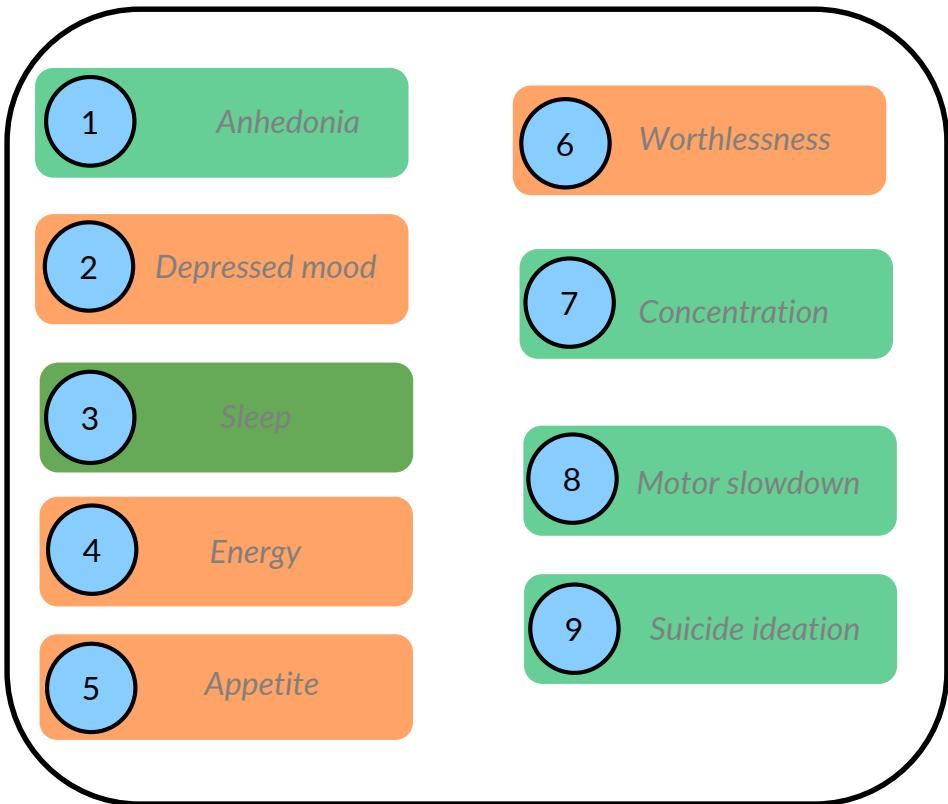
Heterogeneity

Symptoms → diagnosis → treatments



Diagnostic announcement = critical

Heterogeneity



Depression =

- At least 5
- n°1 or n°2

326 profiles

Eiko Fried:

STAR*D (2015):

1030 profiles / 3703 “depressive” patients (DSM-5)



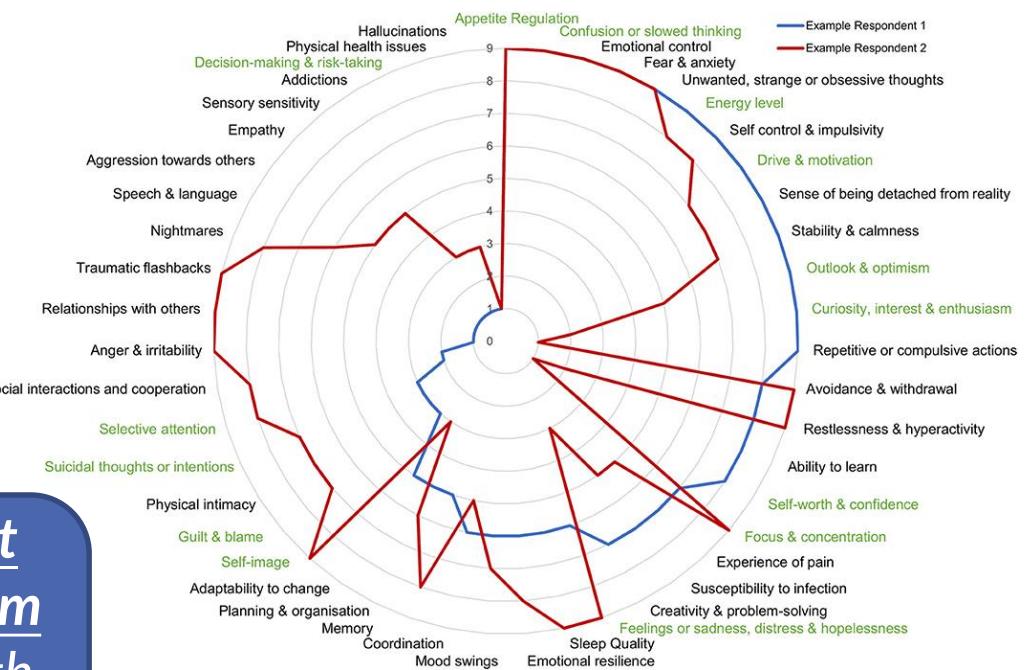
Heterogeneity

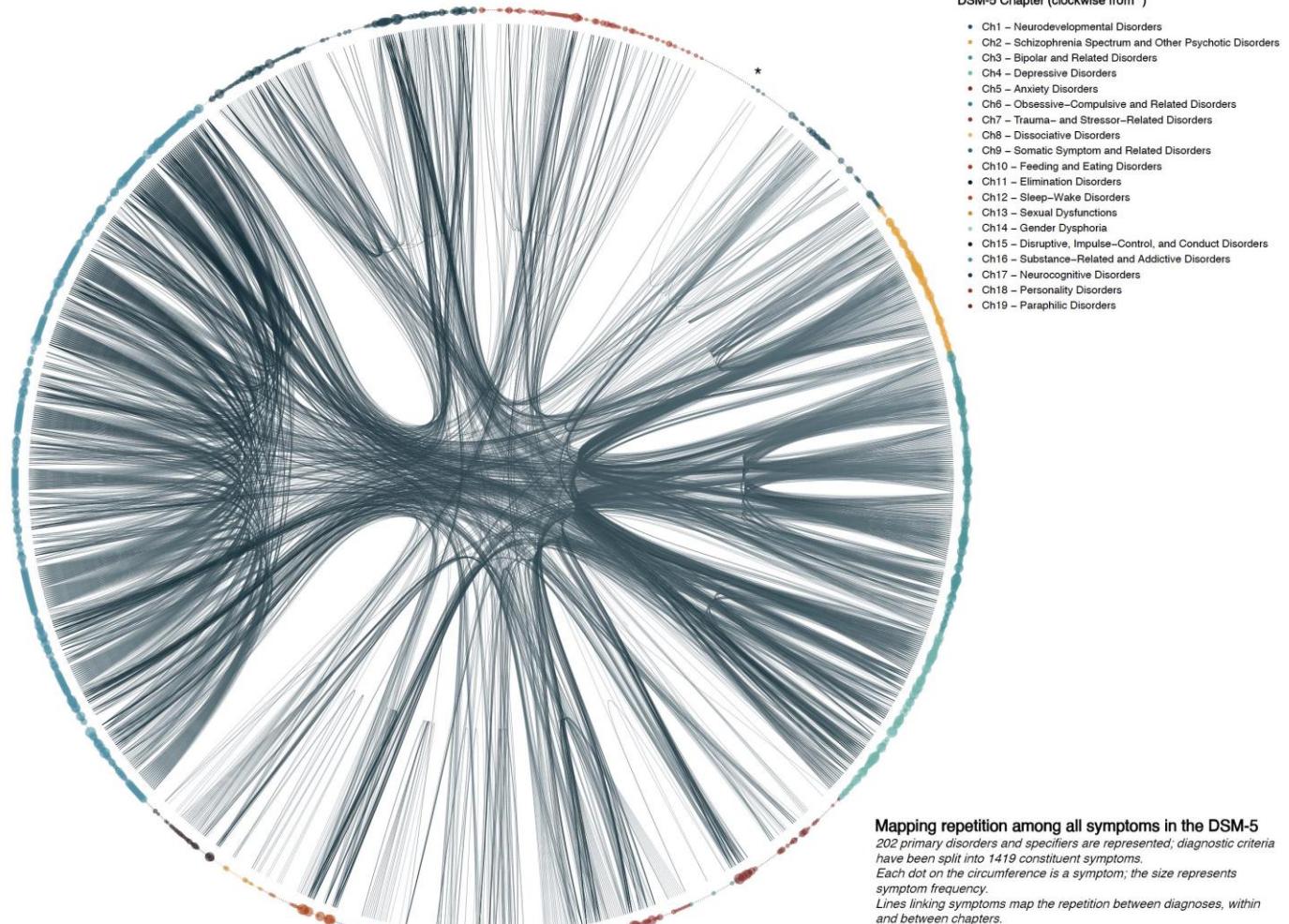
107349 patients

10 most prevalent disorders

47 symptoms

« DSM-5 disorder criteria do not separate individuals from random when the complete mental health symptom profile of an individual is considered»





Why estimating the diagnosis is a bad idea



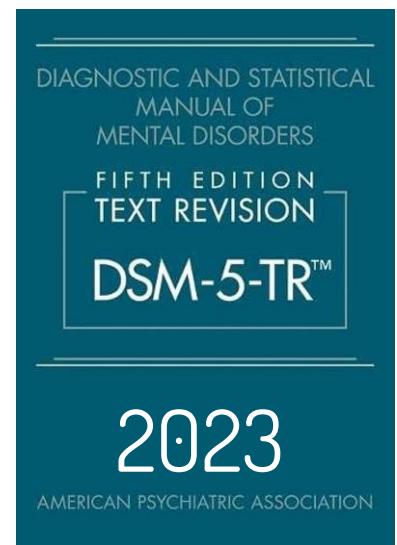
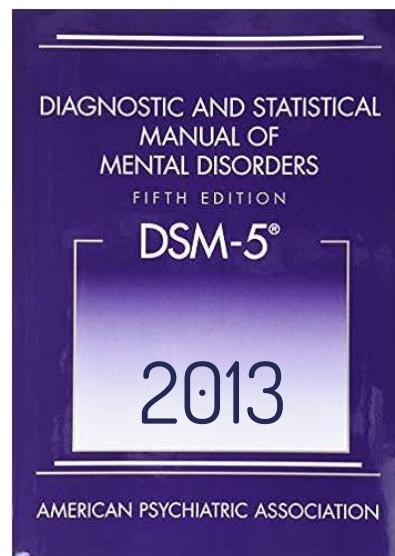
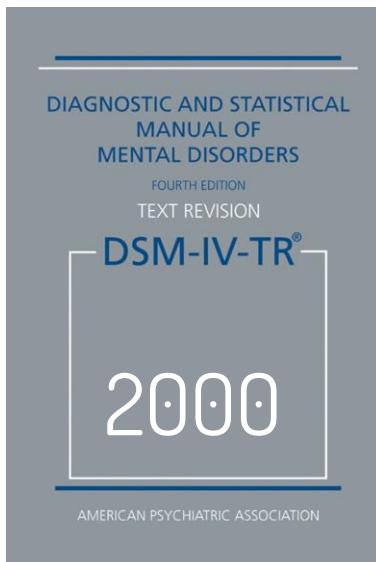
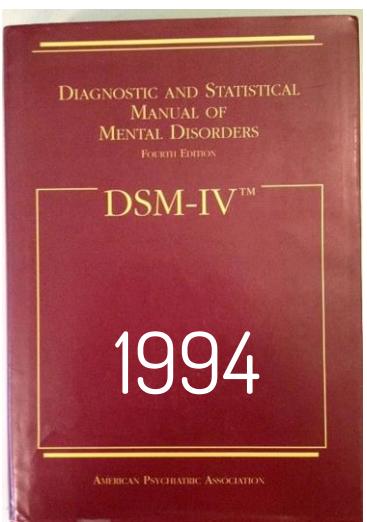
Clinical practice



Heterogeneity

3

Unstability



Why estimating the diagnosis is a bad idea



Clinical practice



Heterogeneity



Unstability

Glossary of Cultural Concepts of Distress

Ataque de nervios

Ataque de nervios ("attack of nerves") is a syndrome among individuals of Latino descent, characterized by symptoms of intense emotional upset, including acute anxiety, anger, or grief; screaming and shouting uncontrollably; attacks of crying; trembling; heat in the chest rising into the head; and becoming verbally and physically aggressive. Dissociative experiences (e.g., depersonalization, derealization, amnesia), seizure-like or fainting episodes, and suicidal gestures are prominent in some *ataques* but absent in others. A general feature of an *ataque de nervios* is a sense of being out of control. Attacks frequently occur as a direct result of a stressful event relating to the family, such as news of the death of a close relative, conflicts with a spouse or children, or witnessing an accident involving a family member. For a minority of individuals, no particular social event triggers their *ataques*; instead, their vulnerability to losing control comes from the accumulated experience of suffering.

No one-to-one relationship has been found between *ataque* and any specific psychiatric disorder, although several disorders, including panic disorder, other specified or unspecified dissociative disorder, and conversion disorder, have symptomatic overlap with *ataque*.

In community samples, *ataque* is associated with suicidal ideation, disability, and out-

Taijin kyofusho

Taijin kyofusho ("interpersonal fear disorder" in Japanese) is a cultural syndrome characterized by anxiety about and avoidance of interpersonal situations due to the thought, feeling, or conviction that one's appearance and actions in social interactions are inadequate or offensive to others. In the United States, the variant involves having an offensive body odor and is termed *olfactory reference syndrome*. Individuals with *taijin kyofusho* tend to focus on the impact of their symptoms and behaviors on others. Variants include major concerns about facial blushing (erythrophobia), having an offensive body odor (olfactory reference syndrome), inappropriate gaze (too much or too little eye contact), stiff or awkward facial expression or bodily movements (e.g., stiffening, trembling), or body deformity.

Taijin kyofusho is a broader construct than social anxiety disorder in DSM-5. In addition to performance anxiety, *taijin kyofusho* includes two culture-related forms: a "sensitive type," with extreme social sensitivity and anxiety about interpersonal interactions, and an "offensive type," in which the major concern is offending others. As a category, *taijin kyofusho* thus includes syndromes with features of body dysmorphic disorder as well as delusional disorder. Concerns may have a delusional quality, responding poorly to simple reassurance or counterexample.

The distinctive symptoms of *taijin kyofusho* occur in specific cultural contexts and, to some extent, with more severe social anxiety across cultures. Similar syndromes are found in Korea and other societies that place a strong emphasis on the self-conscious maintenance of appropriate social behavior in hierarchical interpersonal relationships. *Taijin kyofusho*-like symptoms have also been described in other cultural contexts, including the United States, Australia, and New Zealand.

What is the role of diagnostic ?

- Communication

'one of its most important goal is to **facilitate communication among clinicians, researchers, administrators and patients** [...] by establishing a common language.' Derek Bolton, 2012
- Recognition by society and specialists
→ loop effect (Ian Hacking)

"Some of these individuals will **alter their behavior** due to the **novel self-experience enabled by this classification**, which functions as a **new representation for self-understanding.**"

D. Mourey

What can we do?



Clinical interview = **symptoms & signs**

Treatment = **symptoms & signs**

Estimation of symptoms



Clinical practice



Heterogeneity



Unstability

→ Treatment

→ Diagnosis announcement

→ Fundamental unit of
clinical reasoning

→ Stable through time and
culture

4

Epistemic injustices

5

Health

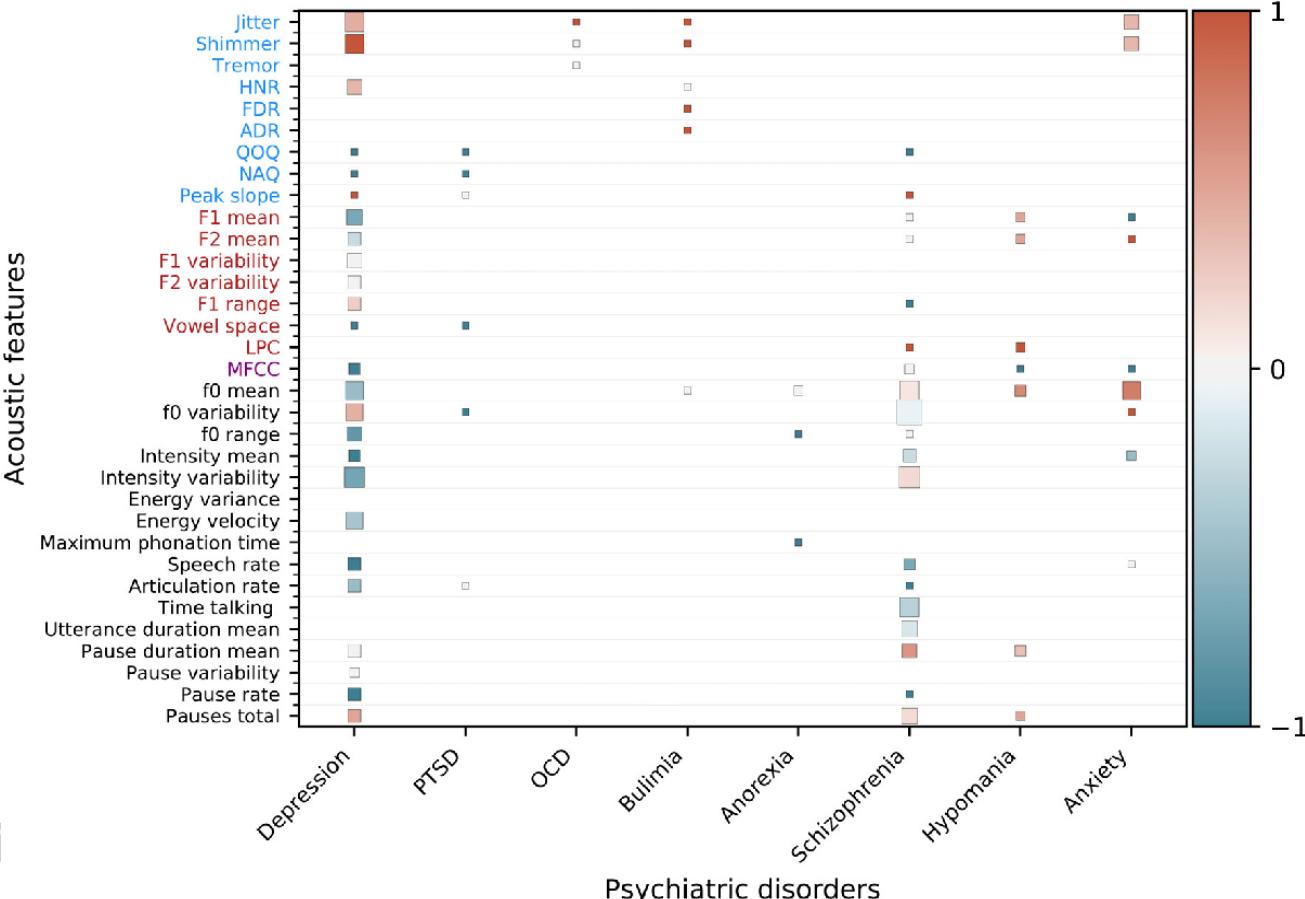
6

New tasks

7

Biomarkers

Estimation of symptoms



Estimation of symptoms



Biomarkers



New tasks



Health



Epistemic injustices

Prognostic

How will the patient evolve in the coming days/weeks/months?

Differential diagnosis

Distinguishing resembling but different disorders (e.g. unipolar depression vs. bipolar disorder)

Therapeutic targeting

Precision therapeutic based on symptoms

Estimation of symptoms



Biomarkers



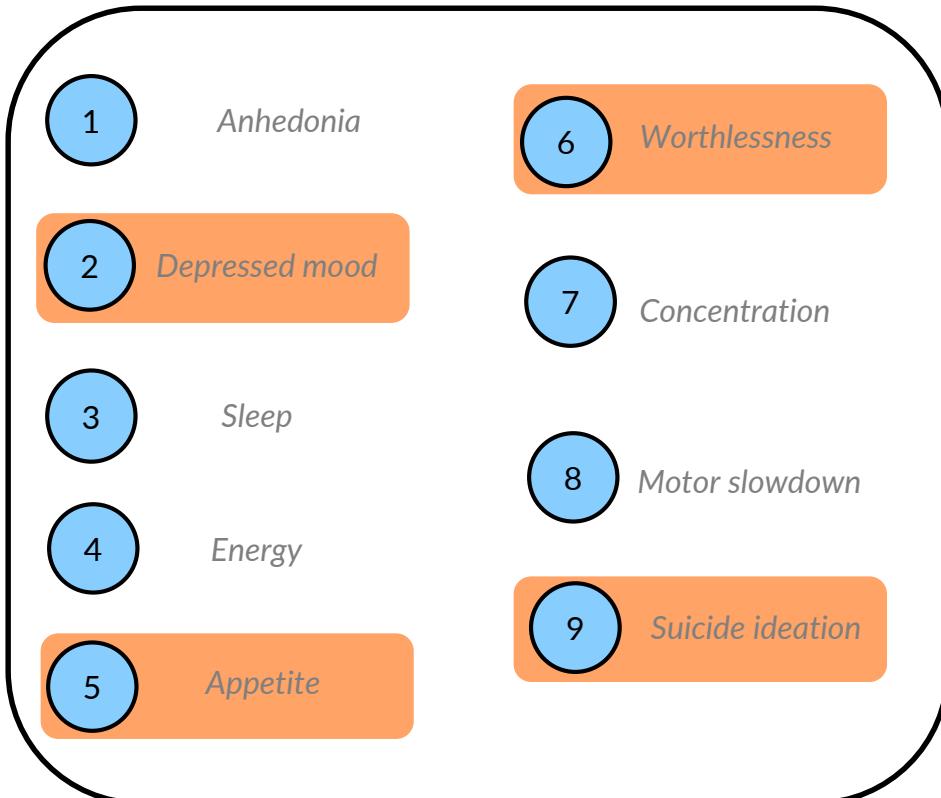
New tasks



Health ≠ Pathology



Epistemic injustices



Estimation of symptoms



Biomarkers



New tasks



Health



Epistemic injustices

Testimonial injustices

→ « objective » evidence

Hermeneutic injustices

→ underrepresented or understudied populations

Clinicians need objective assessments of
psychiatric disorders



Clinicians need objective assessments of
symptoms

Is estimating symptoms instead
of diagnosis enough?

Psychiatrists point of view

515 psychiatrists

1/3 situation

- Smartphone EMA
- Connected wristband
- MRI Machine learning

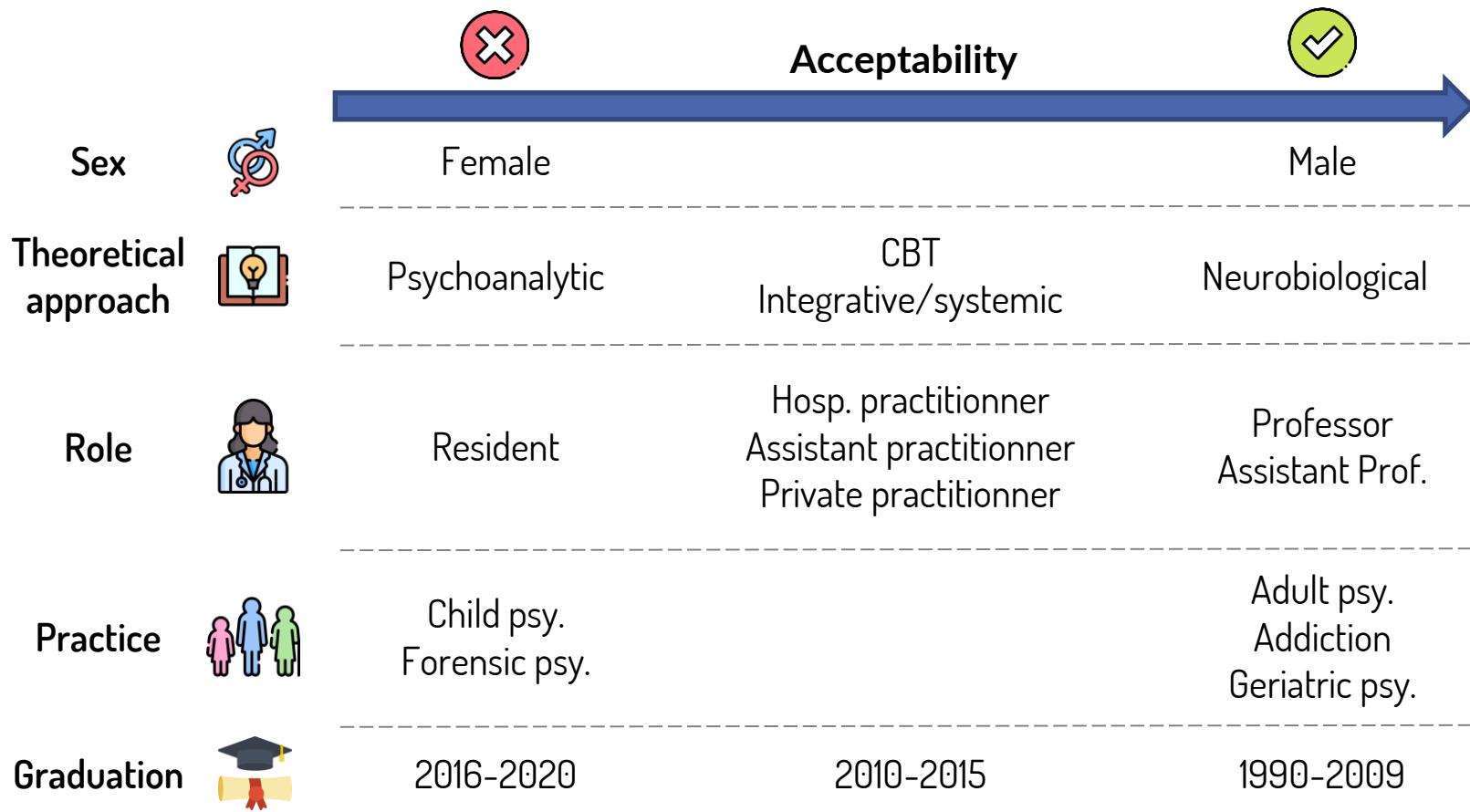


Data privacy
and security



Therapeutic
alliance

Psychiatrists point of view



Clinicians ~~need~~ objective assessments
of psychiatric disorders



Some clinicians may **use complementary**
objective assessments of symptoms

Lessons from self-tracking data

1

23 Danish
General practitioners



[Haase et al. 2023,](#)
Social Studies of Science

2

20 French
Sleep specialists



[Calvignac 2023,](#)
Médecine du Sommeil

3

12 Belgian
GP and cardiologists



[Gabriels et al. 2018,](#)
JMIR



General practitioners



Interestingly, they did not seem to ever explore whether the wearables actually were ‘validated’.

[...] data as relational objects that only make sense when the wider clinical context is known



Recontextualisation
→ actionability



General practitioners



Recontextualisation
→ actionability



Self-reported
questionnaires



Cardiac data



Sleep data

Data from online symptom and health checkers had different evidential value - even when the test was exactly the same - depending on who initiated the test and on which platform it was performed



General practitioners



Recontextualisation
→ actionability



Self-reported
questionnaires



Cardiac data



Sleep data

Regardless of their thoughts about the validity of the actual test results, the GPs investigated the reasons why the patient had conducted the test.

I use them as a springboard for a discussion about ‘but why did you take it?’



General practitioners



Recontextualisation
→ actionability



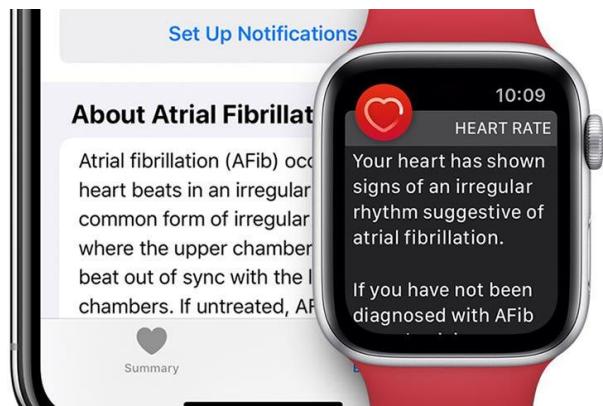
Self-reported
questionnaires



Cardiac data



Sleep data



These patients are here because of an incredibly high measurement, but it is unsure whether there is a real problem or just an error.
[10, cardiologist]



General practitioners



Recontextualisation
→ actionability



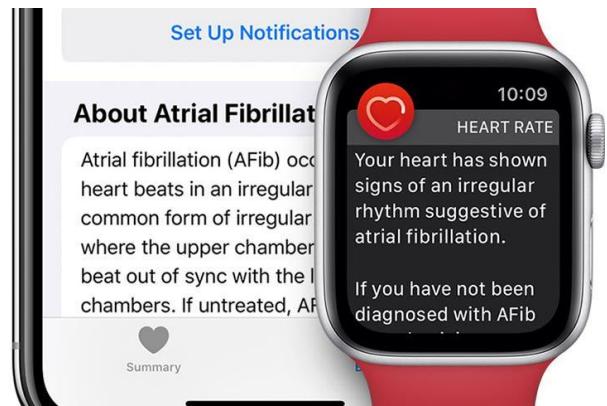
Self-reported
questionnaires



Cardiac data



Sleep data



Complementary
exams

Data were seen as *sufficient to initiate clinical action* or, if the data indicated something harmless, the GPs would immediately dismiss any further investigations.



General practitioners



Recontextualisation
→ actionability



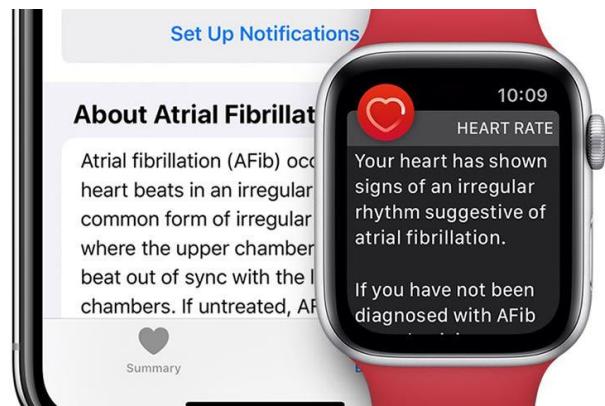
Self-reported
questionnaires



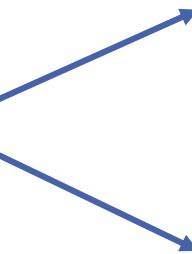
Cardiac data



Sleep data



Complementary
exams



Nothing

"If the clinical information did not indicate a heart disease, Johnny suggests he would consider the data from the wearable insignificant or unrelated to this claim for this specific patient"



General practitioners



Recontextualisation
→ actionability



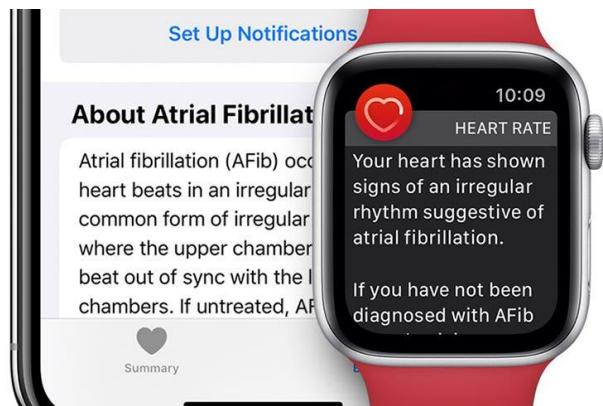
Self-reported
questionnaires



Cardiac data



Sleep data



Complementary
exams

Nothing

"The GPs found it challenging to convince patients that it could be 'normal' (non-pathological) to receive 'abnormal' (beyond certain thresholds) test results."



General practitioners



Recontextualisation
→ actionability



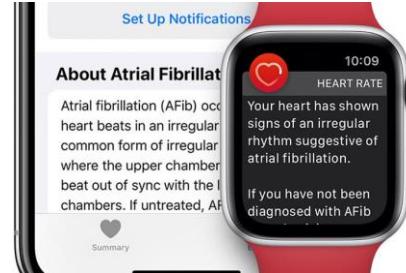
Self-reported
questionnaires



Cardiac data



Sleep data



“At one point, a Saturday evening at 11 pm, I received an e-mail that contained a deviated heart rate measurement. I think ‘hmm, this is strange.’ So I send him [the acquaintance] an e-mail and he lets me know that he was at a reception, where he met someone who said that he suffered from a heart rhythm disorder and he [the acquaintance] subsequently gave him his smartphone to try the technology.”
[12,cardiologist]

Some clinicians may use complementary
objective assessments of symptoms



Some clinicians may use complementary
and contextualized objective
assessments of symptoms



General practitioners



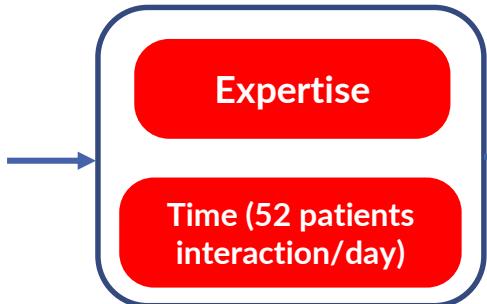
Self-reported
questionnaires



Cardiac data



Sleep data



'my phone states that I am
not sleeping well enough'

"Then I refer some of them [the patients] to a
sleep monitoring clinic but they get rejected"

Lessons from self-tracking data

1

23 Danish
General practitioners



[Haase et al. 2023,
Social Studies of Science](#)

2

20 French
Sleep specialists



[Calvignac 2023,
Médecine du Sommeil](#)

3

12 Belgian
GP and cardiologists



[Gabriels et al. 2018,
JMIR](#)



Sleep specialists



Reliability/accuracy
transparency



Integrating Artificial Intelligence into Medical Education: Lessons Learned From a Belgian Initiative

Ilaria Pizzolla, Rania Aro, Pierre Duez, Bruno De Lièvre, Giovanni Briganti, University of Mons, Belgium

Journal of Interactive Learning Research Volume 34, Number 2, 2023 ISSN 1093-023X Publisher: Association for the Advancement of Computing in Education (AACE), Waynesville, NC

[Journal Info](#) [Table of Contents](#) [New issue alerts](#)

How Explainability Contributes to Trust in AI

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Notions of explainability and evaluation approaches for explainable artificial intelligence

Giulia Vilone*, Luca Longo

School of Computer Science, College of Science and Health, Technological University Dublin, Dublin, Republic of Ireland



Transparency? Actionability? Faithfulness? Interpretability?
Informativeness? Explicability? Explicitness?



Sleep specialists



Reliability/accuracy
transparency



Integrating Artificial Intelligence into Medical Education: Lessons Learned From a Belgian Initiative

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How Explainability Contributes to Trust in AI

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On the Relation of Trust and Explainability: Why to Engineer for Trustworthiness

Lena Kästner*, Markus Langer †, Veronika Lazar†, Astrid Schomäcker*, Timo Speith*‡, Sarah Sterz*‡

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Explainability contributes to trust
Explainability is not necessary for trust





Sleep specialists



Reliability/accuracy
transparency

1

Variety of offers on the market

Most of them provide **inaccurate data** compared to what can be recorded, and often **worry patients** who come in saying, 'I don't have deep sleep' or 'I only have sleep like this or like that,' when **a watch absolutely cannot, at least currently, detect sleep stages** and thus gives a very biased view to patients."

Interview 5, neurologist, public sector, 14 years of experience, Auvergne-Rhône-Alpes.



Patients behavior

'Datadvertising' approaches
= insincere advertising because too flattering.

179

applications

2

publications



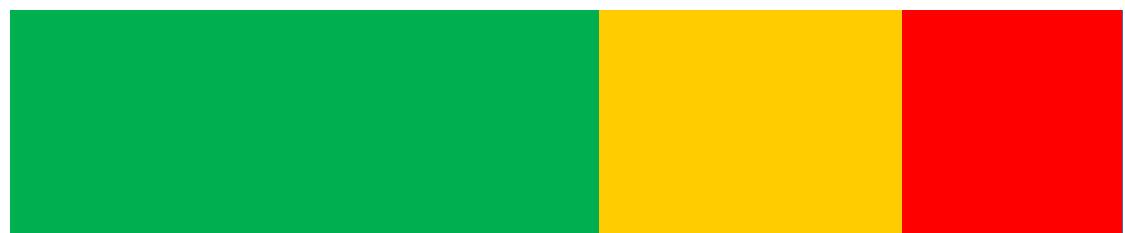
Datadvertising

53% proofs

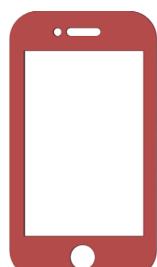
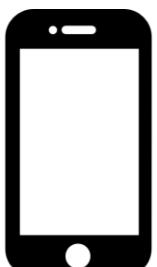
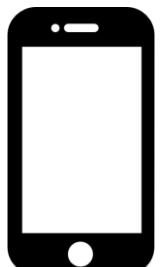
73 applications

49 claims

27% not clear



20% no proof





[Replay 🎥]

👉 La première conférence de la rentrée de la Fondation FondaMental accueillait Pierre-Yves Mousset, président de la start-up **Gynov** et CEO de **NovoBiome**

💡 Face à l'augmentation des besoins en psychiatrie depuis la crise sanitaire, il rappelle la nécessité d'appréhender le soin de manière globale, en tenant compte non seulement des troubles psychiatriques mais aussi des pathologies somatiques.

🧠 Cette approche holistique, basée sur la médecine de précision, permettra la création de start-ups françaises en santé mentale intéressantes pour des fonds d'investissement. Ainsi, NovoBiome s'intéresse aux liens entre notre système digestif et notre cerveau.

➡ Cette conférence est disponible en replay :

<https://lnkd.in/exhcWf2d>

#santementale #mentalhealth #psychiatrie

👉 Ensemble, soutenons l'innovation en psychiatrie. Faites un don à la Fondation FondaMental.



Sleep specialists



Reliability/accuracy
transparency

- 1 Variety of offers on the market
- 2 Validation pop.



Patients behavior



Sleep specialists



Reliability/accuracy
transparency



- 1 Variety of offers on the market
- 2 Validation pop.
- 3 Score transparency and stability over time

'You have a sleep score of 80%.' [What does this sleep score of 80% mean?](#) 80% of what?"

(Interview 6, neurologist, public sector, 30 years of experience, Provence-Alpes-Côte d'Azur)



Sleep specialists



Reliability/accuracy
transparency

"All the professionals interviewed, without exception, initially asserted that, most of the time, **these self-measurements revealed less about sleep itself than about the sleeper**. In other words, it's not so much the data themselves as the act of self-collection that carries meaning."



Patients behavior

Adherence

"The patient who comes in with an app they've been using for three months, where they've noted many things, **it's an important aspect of the patient's personality**, and it becomes a lever for follow-up."

(Interview 8, pulmonologist, private sector, 30 years of experience, Île-de-France)

Some clinicians may use complementary and contextualized objective assessments of symptoms



Some clinicians may use complementary, **transparent, validated** and contextualized objective assessments of symptoms

Lessons from self-tracking data

1

23 Danish
General practitioners



[Haase et al. 2023,
Social Studies of Science](#)

2

20 French
Sleep specialists



[Calvignac 2023,
Médecine du Sommeil](#)

3

12 Belgian
GP and cardiologists



[Gabriels et al. 2018,
JMIR](#)



GP & Cardiologists



Patient autonomy



Patient behavior changes

“There is the *danger that patients will play doctor themselves*. They will themselves decide whether or not to increase their blood pressure medication or diuretic pill. » GP

Doctor I2 (a cardiologist), however, believes *this is not a major problem, as long as patients act within certain limits*. For example, patients with *diabetes* already adjust their medication based on their daily self-tracking of blood sugar levels, which is described as a positive evolution.



GP & Cardiologists



Patient autonomy

I have the feeling that they do measure their parameters and that they are subsequently more aware of the problem, but [that] this does not really lead to behavioral changes.

[4, GP]



Patient behavior
changes

Health performance and health obsession

"Now we all want to be on the same model. People ask you in consultation: 'How many hours should I sleep?' 'What time should I go to bed? *They love rules.* [...] That's the perverse effect of this type of application, this type of connected object, is that *you're given objectives that don't necessarily correspond to your physiology*"

(Interview 8, pulmonologist, private sector, 30 years' experience, Île-de-France).

Calvignac 2023, Médecine du Sommeil



Orthosomnia

"Clearly, when *the Excel spreadsheet is beautifully crafted*, when the graphs are meticulously detailed, we can clearly see the *patient's obsessive nature* [...]"

(Interview 1, neurologist, public sector, 12 years of experience, Occitanie)

Calvignac 2023, Médecine du Sommeil

Worried well cohort

Yes, I expect that health disparities might increase because those who will use it [self-tracking tools] are the ones that are already part of the privileged class.

[2, GP]

Entertainment medicine

“On the one hand I know it [digital self-tracking] will be very useful for certain groups that we currently do not sufficiently reach. [...] But with these apps you perform a whole lot of ‘entertainment’ medicine.”

[7, GP]

Tech billionaire who spends \$2 million a year to look young is now swapping blood with his 17-year-old son and 70-year-old father

BY ORIANNA ROSA ROYLE

May 23, 2023 at 12:42 PM GMT+2



"Young blood" infusions are part of Johnson's \$2 million a year anti-aging routine.

KYLE GRILLOT—BLOOMBERG/GETTY IMAGES

Health vs. performance of health

Stop using these tools

"But then, when people really use them, self-measurement technologies are more of *a factor in fixing symptoms in the wrong sense of the word*, rather than a help. [...] on the contrary, we're going to teach them ... well, we're going to *ask them to detach themselves from these tools.*"

(Interview 13, psychiatrist, private practice, 40 years' experience, Paris region)

Calvignac 2023, Médecine du Sommeil



Tool of self-investigation

They [the patients] come and say, 'my phone states that I am not sleeping well enough', then I ask 'well, are you tired?' [the patients answer] 'no I am not' [then I ask] 'do you have a problem then?' [laughing]

Haase et al. 2023, SSS

[...] People need to get to know themselves. It's also our job [...] to explain to them how to get to know themselves."

(Interview 8, pulmonologist, private sector, 30 years' experience, Île-de-France).

Calvignac 2023, Médecine du Sommeil

Mechanical vs. Situated objectivity

Mechanical objectivity

= evidence that is ‘uncontaminated by interpretation’

Mechanical objectivity transforms life, in all its ambiguity and messiness, into something manageable

“living *by* numbers”

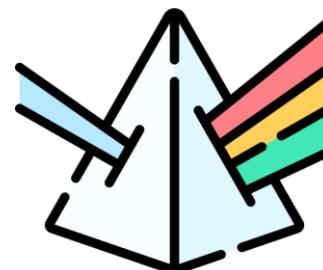


Situated objectivity

= everyday \times (mechanical objectivity + trained judgement)

The objectivity that people apply to evaluating measurements transforms numbers and charts into ‘qualitative metrics’

“living *with* numbers”



Some clinicians may use complementary,
transparent, validated and contextualized
objective assessments of symptoms



For some patients, some clinicians may use
complementary, transparent, validated and
contextualized objective assessments of
symptoms

To go further

Align patient and clinician objectives

1

- B1.1: Patient motivation is not always obvious
B1.2: Misaligned objectives

Evaluate data quality

2

- B2.1: Unclear accuracy and reliability
B2.2: Data is often incomplete
B2.3: Data often lacks context

Judge data utility

3

- B3.1: Insufficient time
B3.2: Data can be irrelevant
B3.3: Data can be distracting
B3.4: Poor interoperability

Decide on a plan or action

6

- B6.1: Patient-generated data not considered concrete evidence
B6.2: Data use limited by practice or training

Interpret the data

5

- B5.1: Ambiguity in subjective data
B5.2: Unclear meaning of missing data
B5.3: Reliance on patient recall

Rearrange the data

4

- B4.1: Unfamiliar structure
B4.2: Unhelpful structure

Conclusion

[...] the GPs spend little or no time judging the quality of an app before suggesting it to the patients.

“Because I have tried to download it and it seems manageable. Ehm, and it is *purely random*.”

Note how Lene suggested apps when *the interface was nice and the app ‘free’*, not based on an assessment of clinical relevance and validity

Despite suggesting a specific app, Benedicte apparently considered the sleep apps on the market as equal. She did not want to spend time on analysing apps, and she was not paid to do so.

Instead of asking the people involved in a problematic situation, developers, educators, technologists and sociologists get their information about 'what these people really want and need' from theoretical studies carried out by their esteemed colleagues in what they think are the relevant fields. **Not live human beings, but abstract models are consulted; not the target population decides, but the producers of the models.**

Paul Feyerabend, *Against Method* (1975)



Heterogeneity of disorders

PISTEMOLOGY



Interference with therapeutic relationship

SOCIOLOGY



Responsability of clinican decision

ETHICS



No improvement in follow-up

PSYCHIATRY



Voice biomarkers of
DISORDERS

COMPUTER SC.

INNOVATION



Accessible



Regular



Ecological



Supplementary
information



Heterogeneity of
disorders



Clinicians stay at the heart
of the care

PISTEMOLOGY

SOCIOLOGY

PSYCHIATRY

ETHICS



COMPUTER SC.

INNOVATION



Accessible



Regular



Ecological

Voice biomarkers of
SYMPTOMS



Improvement of the follow-up

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