ENS, Dividnorm

March 14, 2013

What noetic feelings tell us about the relations between emotion and cognition

Joëlle Proust
Institut Jean-Nicod
Paris

http://dividnorm.ens.fr

Goal of the present talk

- Elaborate a view of noetic feelings aimed to clarify their emotional nature, their specific function, content, scope, and neural implementation.

Outline

1. The functions of noetic feelings
2. How do they fulfill these functions?
   A. A cognitivist theory
   B. Noncognitivist theories
3. The content of noetic feelings: a proposal
4. An architectural problem: assymmetry of norm-sensitivity in feelings.

Conclusion: proposal for a dual-system theory of norm sensitivity

1 - The functions of noetic feelings

Noetic feelings have 3 functions

- Evaluate correctness in past or future cognitive performance : monitoring aspect
- Motivate epistemic decision accordingly: control aspect.
- Be a source of entitlement for taking one's decision to be the correct one: epistemological aspect.

Noetic feelings occur in a metacognitive episode

Metacognition is the set of abilities that allow humans (and some non-humans)

- to evaluate the cognitive adequacy of their dispositions to obtain a given cognitive output and
- to control their cognition accordingly.

Central examples of metacognition

- **Prospective monitoring** (evaluating one's ability to carry out a cognitive task)
- **Retrospective monitoring** (judging the adequacy of a cognitive response)
- **Ease of learning judgments** (reducing uncertainty on time needed to learn)
- **Judgments of learning** (assessing how well material will be retrieved after a delay)
- **Knowing judgments** (evaluating own uncertainty about belief accuracy)

Metacognition is part of cognitive agency

- A bodily action is a controlled behavior which one intends to result in some physical change in the world or in the self
- A cognitive action is a controlled sequence of operations which one intends to result in some cognitive change (e.g. retrieving a name, discriminating two patterns)
- When acting, one needs to proportionate one's goals to one's mental as well as bodily resources:

→ **the function of NF is to gauge the feasibility or adequacy of a particular cognitive action.**

NFs are activity-dependent

- You can only have a noetic feeling if you are engaged in a particular cognitive activity
- Basic emotions, moral and aesthetic emotions, in contrast, are **response-dependent.**

The steps of epistemic self-evaluation

Metacognitive evaluations need to occur:

- before the action is launched (is it feasible?)
- Once it's been performed (is it successful?)

Noetic Feelings

Predictive

- cognitive effortfulness
- Familiarity
- knowing
- Tip of the tongue
- Coherence, incoherence

Retrodictive

- Uncertainty about correct performance
- Uncertainty about existing competence
- Feeling of being right

Self-probing

Before trying to perform a cognitive action, one needs to know whether, e.g.,

- Some item is in memory (before trying to retrieve it)
- One has epistemic competence in a domain (before one tries to predict an event)
- One is sufficiently motivated to act in a certain way (when planning)

Post-evaluation

- Performing a cognitive action entails the ability to evaluate its success
- One needs to know, e.g., whether
  - ✓The word retrieved is correct
  - ✓One's reasoning is sound
  - ✓One does not forget a constraint while planning

The first function of Noetic Feelings: summary

Consists in **evaluating correctness, which involves** comparing an observed with an expected value.

- In Self-probing: they predict how feasible the cognitive action is, given a stored standard
- In Post-evaluating: they report how successful the action has been, given a stored standard

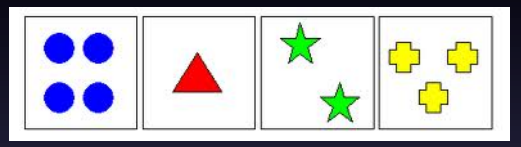
The second function of Noetic Feelings

Once a performance is appraised, noetic feelings are supposed to motivate a decision in agreement with the appraisal (e.g., launch the cognitive action/accept its cognitive output)

This second step involves “control sensitivity”: agents can have reliable feelings of confidence in a performance, and fail to apply them adequately.

Monitoring vs control

- Patients with schizophrenia correctly evaluate the correctness of a given performance in a Wisconsin Card Sorting Test,



- But they are often unable to correctly apply their own feeling of correction to make appropriate decisions.

(Koren et al. 2006)

Third function: epistemological (in humans)

- Noetic feelings allow agents to reliably evaluate their epistemic states
- They are the potential basis of agents' being entitled to taking their perception, memory, etc. to be valid.

Burge (2003), Proust (2008)

The third function: epistemological

To be reliable,however, noetic feelings must be:

- Well-calibrated: the standard (expected value) for a cognitive task must be based on previous sufficient, unbiased recurring feedback. *(Loussouarn et al. 2011)*
- Relevant to a given epistemic acceptance
- Sufficiently informative for an appropriate decision to be taken.

2 – How do noetic feelings fulfill these three functions?

A cognitivist theory of noetic feelings

In a cognitive view of NFs, they result from a **judgment about** one's ability or performance

- Cognitivists about emotions claim that emotions involve propositional attitudes. (Solomon 1993).
- Thus noetic feelings should be attitudes directed at one's own cognitive dispositions or (memorial, perceptual, reasoning) outputs.

In a cognitive view of NFs, they result from a **judgment about** one's ability or performance

- One can't be angry with someone unless one believes that person guilty of some offense;
- Similarly, one can't be uncertain about one's perception unless one believes that one is currently trying to perceive something, and that this trying does not meet a standard.

In a cognitive view of NFs, they result from a **judgment about** one's ability or performance

- An attitude of this kind in turn presupposes having concepts about the kind of cognitive activity being assessed (e.g. perception, memory, etc.) and about the norms involved in it, such as truth, accuracy, etc.

In a cognitive view of NFs, they result from a **judgment about** one's ability or performance

- The feeling of knowing that one knows something involves a metarepresentational state of knowledge such as "I know what the capital of Australia is".
- This theory calls for a substantial theory of introspection (Dokic, 2012)

How does a cognitivist view account for the three functions of NF?

- Control and monitoring: As in Shallice (1988): metarepresentation generates additional control & monitoring capacities.
- Motivation: Having assessed one's reasons to believe with a given degree of certainty motivates one to decide how to act.
- Explicit justification of one's reasons to judge one's performance to be correct is a condition for epistemic entitlement.

Discussion

Why NFs do not need to involve propositional attitudes

Animals and young children do not have concepts of mind and self, and little if any of the world, yet:

- they have emotions such as fear, disgust, etc.
- they have NFs, such as feelings of familiarity and of uncertainty.

Having the relevant propositional attitudes does not need to produce noetic feelings

Furthermore, noetic feelings do not need to be involved in the corresponding propositional attitudes:

One may believe/know that one's cognitive performance is correct without having the corresponding feeling (ex: mathematical proof).

Non-cognitivist theories

Noncognitivist theories of noetic feelings

- On noncognitivist theories of noetic feelings, the latter are mere experiences triggered by certain aspects of the first-order cognitive task
- These theories differ in how the trigger is identified

A noncognitivist theory of noetic feelings: Hart (1965)

- One's feeling of knowing reveals that one possesses information relevant to answering a question.
- The content of the potential answer is found to be present in memory (« memory trace »)

→ The feeling of knowing monitors the « memory trace ».

How does a trace theory account for the three functions of NF?

- Control and monitoring: content monitoring determines epistemic control
- Motivation: Feelings motivate one to decide to pursue or stop current activity
- Epistemic entitlement grounded in partial access to memory content and in the associated feeling of knowing being reliable.

A noncognitivist theory of noetic feelings: Hart (1965)

- Experimental refutation of the memory trace theory
- Strong feelings of knowing can be generated by questions for which the subject does not have the answer (Koriat & Levy-Sadot 2001).

A noncognitivist theory of noetic feelings: Koriat (2000)

- On an alternative noncognitivist view, noetic feelings are a form of conscious, complex experience that does not require access to the content of first-order task, but rather requires access to properties of the control and monitoring activity.

A noncognitivist theory of noetic feelings: Koriat (2000)

The « cross-over principle »

- unconscious heuristics extracted from the feedback of a mental action – such as the effort heuristic – causally determine conscious noetic feelings.

How does the noncognitivist theory of NFs account for their three functions?

- Control and monitoring: the noetic feelings directly reflect the difficulty inherent to the task, in its monitoring aspects.
- Motivation: Feelings motivate one to decide to pursue or stop current activity based on structural features of the task.
- Epistemic entitlement grounded in the externalist consideration that noetic feelings reliably correlate with task success

A neo-cognitivist theory of noetic feelings: Koriat & Nussinsson (2009)

A new theory, however, has been issued to explain how putative noetic feelings could apply to judgments of learning.

A neo-cognitivist theory of noetic feelings: Koriat & Nussinsson (2009)

William James (1884)

Emotional feelings are based on the feedback from one's own bodily reactions.

A neocognitivist theory of noetic feelings: double feedback theory (K & N, 2009)

Noetic feelings can result from a double

independent source of feedback

- from the vehicle of cognitive activity (as in James and in Koriat 2000)
- from the control of cognitive activity

Feedback associated with monitoring the vehicle of cognitive activity

Includes a variety of cues that are generated by the activity:

- Bodily changes (e.g., in facial muscles)
- Time comparatively spent in performing the task
- Coherence of responses activated by the task

Feedback related to control of activity

- Under time pressure, learners tend to allocate more study time to the easier rather than to the more difficult items (« goal-driven regulation »).
- In self-paced tasks, learners tend to allocate more study time to the the more difficult items (« data-driven regulation »)

How is one type of feedback selected as a source of NFs in JOLs?

- « Because of the opposite implications of the two types of regulation to JOLs, an attribution process must be postulated in which effort is attributed in different proportions to the two sources in making recall predictions. » (Koriat and Nussinson, 2009)

Hence neo-cognitivism

- « Participants **can be induced to adopt different and even opposite theories about the implications of processing fluency,** and these theories, in turn, modulate participants' judgments » (Koriat & Nussinson 2009)

How does the double feedback theory account for the three functions of NF?

- Control and monitoring: the noetic feelings reflect the difficulty inherent to the task, in both its control and monitoring aspects, as determined by an attribution process
- Motivation: Feelings motivate one to decide to pursue or stop current activity based on interpreted structural features of the task.
- Epistemic entitlement grounded in the externalist consideration that noetic feelings reliably correlate with task success, given a rational attributional process.

Discussion

- Koriat's resulting hybrid theory of noetic feelings defeats the « cross-over principle » defended in his (2000):
- It's no longer the case that unconscious heuristics causally determine conscious feelings. Feelings are also determined by a conscious attributional process.

Problems

- The neocognitivist view only holds for agents able to metarepresent their mental states
- No attention has been given to the fact that JOLs are intrinsically metarepresentational, in contrast to TOTs, feelings of familiarity, or feelings of knowing.

How to explain that

- Feelings can bear information about an occurrent disposition to solve a cognitive problem without an associated metarepresentatonal ability?
- Feelings can also be present when metarepresentations of the task are engaged?

A plausible way out

- Noetic feelings are only a subset of the factors that can guide epistemic decision
- Beliefs about task or self can either waiver their guidance, or modulate it.
- How is this possible?

3 – A theory of content for noetic feelings

Sketch of a solution

- Feelings are nonconceptual representations, i.e.: they have an informational structure, which analogically maps an occurrent cognitive disposition or affordance.
- These representations are autonomous from conceptual representations, but can also be redescribed in conceptual terms in organisms possessing the relevant concepts.

Summary of the constraints

- The content of feelings cannot be propositional (metarepresentations non necessary)
  - →they cannot be « about » a state of memory, perception,
  - →They rather express a relation between present dispositions and an epistemic affordance.
- They should be sufficient (in certain contexts)
  - to control and monitor epistemic decision
  - Motivate it
  - Entitle a cognitive agent to make epistemic decisions

How to capture the kind of nonconceptual representational format in which noetic feelings are expressed?

Feature-placing systems generalized

Feature-placing representational systems (FPS)

- were originally proposed to explain animals' ability to navigate through space, and register states of affairs without concept possession, generality, or objectivity.
- In FPS, a feature, as opposed to a property, is represented as exemplified or "incidental", with no sense of a contrast between a representing subject and a represented object.

See Strawson (1959), Cussins (1992), Campbell (1993), Dummett (1993), Bermúdez (2003), B.C. Smith (1996), Glouberman, (1976).

A feature placing representational system

- A standard example of a feature-placing representation is: Water ! (here, now)
- can be reformulated by:

  Some (much, little) drinking affordance (here, now)

A feature placing representational system

- Content includes:
  - An affordance,
  - An affective valence
  - A quantity or,intensity on a gradient scale,
  - An action program
  - A present time and neighboring location

In a feature-placing representational system

- Agent-centered organisation of spatial nonconceptual representations (Peacocke, 1992)
- Content triggers the associated motor program. (Cussins, 1992)
- **Non-inferential** kind of information (Crane, 1988).

Proposal: **Feature-based representational systems** (FBS) (Proust, 2009, in print 2013)

- ✧ A FPS evaluates an *environmental affordance* as being incident (at a time and at a location).
- ✧ A FBS evaluates an epistemic affordance as being incident (at a time*): e.g.*,

  Now, poor (excellent etc.) *A*-ing affordance

  where A-ing is the current cognitive performance: remembering, discriminating, etc.
- Content triggers the associated *cognitive program* (trying to remember, accepting and deciding what to do, etc.)

A particular noetic feeling is constituted by fine-grained dynamic properties, including:

- Relative intensity of a cognitive affordance (calibrated across similar past episodes)
- Temporal profile (onset/duration, intensity/time)
- Associated motivation for acting.

Example: TOT feelings (Schwartz et al., 2000): feedback from vehicle

Appraisal processes

Peripheral expression

Action tendencies (« affect programs »)

Subjective feelings

- Word within reach or not
- Muscular activation in tongue
- Motivates longer search in memory
- Variable in
  - Intensity,
  - Emotional content,
  - Sense of imminence

TOT : Schwartz et al., 2000

More intense	→higher resolution rate →Higher recognition rate →FOK
More emotional	→better recognition, →not better resolution (retrieval blocking)
With feeling of Imminence	→ better resolution → better recognition.

NFs and the dynamics of the neural vehicle

Why are NF reliable in tracking cognitive affordances?

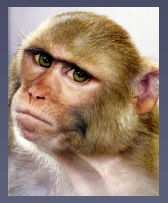
Because dynamic cues can, in a number of cases, be extracted from the associated vehicle and used to evaluate future/past performance.

The neural correlates of procedural metacognition in rhesus monkeys

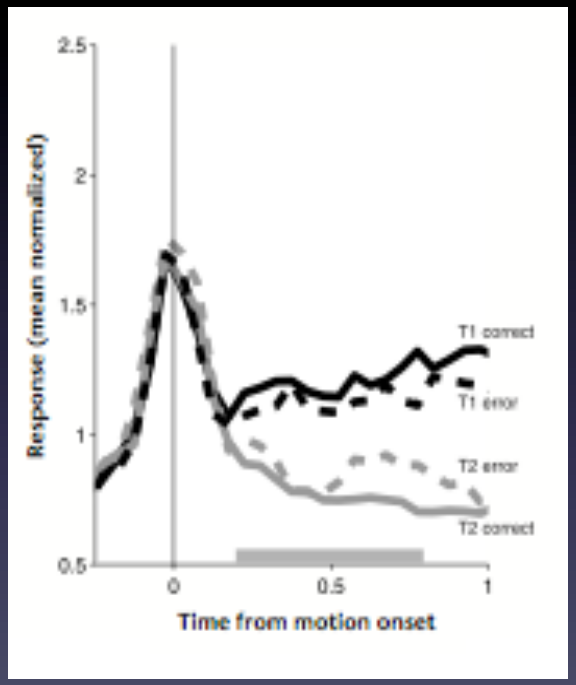
were studied in an opt-out task, where monkeys must

- discriminate whether a shortly presented stimulus is moving left or right.
- respond, after a delay, with an eye movement.
- “Sure bet” option available in some trials

(Kiani & Shadlen, *Science,* 2009)



How to implicitly access one's own uncertainty?

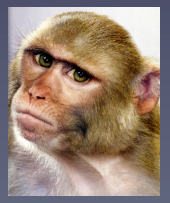


- Neurons predicting a saccade in a given direction respond less strongly in the erroneous decisions (dashed lines).
- This difference is the basis for judments of confidence about decision.

Kim & Shadlen, 2009

Kiani & Shadlen, 2009

- They found that the firing rate of neurons in the lateral intraparietal cortex (LIP) correlates with the accumulation of evidence, and the degree of certainty underlying the decision to opt out.
- This result fits nicely with an accumulator model of judgments of self-confidence.



The accumulator model

. Evidence for the two alternatives is accumulated in parallel, until one of the evidence totals reaches a criterion value, and the associated response is emitted.

Vickers & Lee, 1998

The accumulator model

An adaptive accumulator is a dynamic comparator, where the values compared are rates of accumulation of evidence relative to a pre-established threshold for each possible answer.

How is calibration performed?

- A secondary type of accumulator, called "control accumulator", accumulates positive and negative discrepancies between the expected and the observed levels of confidence in two independent stores.
- If, for example, a critical amount of overconfidence has been reached, then the threshold of response in the primary accumulator is proportionally reduced

Vickers & Lee, 1998).

.

How does this featural account for the three functions of NFs?

- Control and monitoring: control inherent to affect program associated with the NF. Monitoring inherent to the intensity of the affordance
- Motivation: derived from the valence and intensity of the affordance constituting the NF.
- Epistemic entitlement grounded in the reliability of the detection of epistemic affordances in the system (amount of feedback, calibration)

Summary

- Nonconceptual representations of FBS carry information about cognitive affordances through dynamic properties of the vehicle
- Cognitive effort/ease of processing are assessed on the basis of activity onset, duration and intensity
- NFs are not rooted in a critical understanding of the cognitive contents involved.
- They are activity-dependent

Noetic feelings: why are they emotional phenomena?

- Emotions are not evaluative judgments, but evaluative nonconceptual registerings that motivate an organism to act in a certain way.
- The nonconceptual registerings distinctive of emotions involve graded valences corresponding to graded affordances.

Are there noetic feelings that are not based on fluency?

The hierarchy of feelings

- Is fluency the only source of noetic feelings?
- Two views:
  1. There may be noetic feelings at any level in the hierarchy of self-evaluative thoughts (Arango, 2012)
  2. Noetic feelings only occur in feature-based representations of affordances, but they are called, wrongly, feelings of knowing.

Noetic feelings are based on fluency (ease of processing)

- Comparative fluency is the property, for a stimulus, to be processed more or less quickly and adequately, with respect to what is expected, in a kind of task
- This property is a gradient on a normative scale: it works as an indicator for what successful processing should be like, for a task in a context.

A striking contrast in ways of appraisal

1. Vehicle-sensitive noetic feelings (sensitivity structured by the neural properties underlying fluency) influence a range of epistemic decisions.
2. Content-sensitive epistemic decisions do not seem to elicit sui-generis feelings.

Different decisions are made by each «evaluation system »

Koriat & Ackermann, (2010)

A judgment of learning is one that predicts how well the learner will be able to remember a particular studied item after a delay.

- Subjects are asked to provide such judgments either
  - after having performed the task or not
  - concerning their own or others' performances

A remarkable dissociation

Off-line evaluation

- participants rely on the naïve, incorrect theory that longer study time predicts better performance
- in a self-paced learning task, devoting more time to a pair of words is taken to predict **better retrieval** for that pair.

On-line evaluation

- participants judge correctly that longer study time predicts poorer performance
- "memorizing effort heuristic", based on dynamic cues such as time spent and rate of accumulation of evidence.

(Koriat & Ackermann, 2010)

Similar results for metaperception

Off-line evaluation

- participants rely on the naïve, incorrect theory that they can accurately and rapidly detect changes in a perceptual lay-out: "change blindness blindness"

  (Levin et al., 2000)

- Plausible folk belief: A longer search time predicts a more accurate perceptual judgment (not tested)

On-line evaluation

- participants judge correctly that a longer search time predicts poorer detection performance
- "perceptual effort heuristic", based on dynamic cues such as time spent and rate of accumulation of evidence.

(Loussouarn , Gabriel & Proust, *Consciousness and Cognition, 2011*)

The converse dissociation: Schwarz (2004)

How do you rate your memory?

- If invited to retrieve 12 childhood events, subjects rate their memory as less reliable than when having to retrieve six events → effort heuristics does not correlate with memorial ability
- A yoked participant attributes a higher memorial ability to subjects retrieving more events.

A non theory-laden explanation

- Norms such as fluency are automatically associated with a type of task.
- Subjects don't need to have « a theory » about what to do: control automatically uses the feedback that, in the past, was predictive of success.

Overruled, not suppressed

- Noetic feelings can be overruled by beliefs on what to decide.
- However: they cannot be suppressed (automatic, inflexible)
- As a consequence of their representational format, they are not open to:
  - Inference
  - revision

Conclusion

A two-system view of metacognition?

A contrast between norms.

- Fluency is a norm that is inherent to processing, and that gives rise to specific feelings (familiarity, confidence in perception or in memory)
- Other norms, such as truth or plausibility, are inherent to evaluating a cognitive content.

→ Contrast between two forms of metacognitive norms: experience-based (procedural) and concept-based (analytic).

The 2-system view revised

- Granting that System 1 generates nonconceptual contents in a featural format, the contrast with System 2 is one between two ways of forming and using representations.

System 1

- Vehicle-based
- Inflexible
- Economical
- Nonconceptual
- Gradient structure
- Modular
- Non inferential

System 2

- Content-based
- Flexible
- Costly
- Conceptual
- Componential structure
- Non-modular
- Inferential

Inflexibility

- Inflexibility has nothing to do with the fact that feelings are « generated by subpersonal processes ». All our flexible thoughts are also generated subpersonally.
- System1 inflexibility derives, rather, from the *nonconceptual format of representation that is used to drive decision.*

What kind of binding is there between S1 and S2?

- The binding between the two systems is the same as that studied in the philosophy of perception between nonconceptual protopropositional content, and propositional content.

What kind of binding is there between S1 and S2?

- The nonconceptual content of perception is inserted within a propositional format including terms for concepts and objects.
- Analogously, children's NFs are redescribed in conceptual terms.

What kind of binding is there between S1 and S2?

- When a System 2 is present, agents have access to propositional representations of their cognitive goals, and can assess their cognitive resources under new types of norms.
- Although this assessment may take marginal advantage of NFs (e.g.: intelligibility), it is not mainly based on cognitive emotions.

THANK YOU FOR YOUR ATTENTION !

This presentation is available for download on :

http://www.joelleproust.org