What is Logical or Rational Thinking, and how does it relate to Reasoning, Heuristics, Biases and the Rationality Debate?*

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There are two different types of intelligence - one type can be measured objectively (i.e. perceptual speed and memory), and the type of intellect is subjective and, although it can be measured, is still subjective. The subjective type of intellect consists of things like reasoning ability and verbal comprehension.

I stated that something like verbal comprehension is subjective; however that statement is actually a big idea (if you think about it). It is basically saying that every words definition is up for debate, or subject to opinion. That is true, however - for instance the meaning of each word for each person may be different. When someone says the word 'dog' maybe they mean to use the word as a metaphor and really mean, 'that person is like a dog' not 'that is a dog'. Maybe even when someone says 'that is a dog' they are making a subjective statement, even though it seems pretty objective. - I mean a dog has a strict definition and most people have the same thing in mind when they think of that word, therefore making its meaning rather straightforward.

My point is that different kinds of emotional understanding (which are largely things in life that are 'subjective') make up life, the words people use, and common human understanding. Therefore nothing is ever really 'objective' because it is subject to human biases. Mathematical equations are objective, however if a animal were to look at a math problem they might not understand it as being objective - they might interpret the problem to mean something else (since it wouldn't mean anything to them mathematically).

People have beliefs of various sorts. These beliefs influence their thinking and how they feel.

What else is to be said about subjective reasoning?

What else is to be said about what I have called 'subjective reasoning'? I am labeling reasoning ability as being biased and subjective in any case where emotional information is handled, which is all the time unless something is completely objective. However, nothing is completely objective because even a math problem is going to cause someone to be emotional or process it emotionally in some way. That is why I am saying that all reasoning ability is actually a sort of 'subjective reasoning'.

I mean, if you think about it, most if not all of life involves dealing with your own personal feelings - whether you are aware of it or not. Feelings are always present, they bias your decisions, and they motivate your behaviors and thoughts.

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Feelings effect our lives
How is someone supposed to know when their feelings or other ideas they have (such as a belief about something) influence their decisions or thinking?

Is most of thinking emotional and biased? Or is most of the thinking people do fairly straightforward and not involve making complex (and potentially influenced by feeling) decisions?

the most emotionally relevant factor is the motivator
Goals can be changed by how motivated someone is to have that goal. Some goals can be brought into conscious awareness at various times for various reasons. Simon (1967)[1] reasoned that emotions are calls for reprioritization: that emotion regarding a goal that is out of awareness eventually induces people to give that goal a higher priority. The stronger the emotion, the stronger the claim for higher priority. Affect pulls the out-of-awareness into awareness.

Simons analysis was just referring to goals. However, if you think about it, all of someones thoughts might follow a similar logic - the logic being that the most emotionally relevant thought has the highest claim to priority.

So if someone wants something, then they are emotionally motivated to think certain things because thinking those things will generate more pleasurable emotions.

computational components underlying intelligence
What are the computational components underlying intelligence?

To begin, I ask the question - is thinking straightforward or is it complicated?

When people think, they are constantly making emotional assessments of various sorts. They think about their own motivations, i.e. how they feel about different things, and what their goals are going to be based on those motivations.

Individual thoughts also mean something emotionally. Anything someone thinks is going to be associated with different feelings and preferences.

Does this mean that thinking is simple and logical? People think all of the time, what guides their thoughts are emotional preferences that were formed from previous development or at birth.

1 Semantics versus Cognitive Representations

Louis Narens[2] presents the idea that there is a difference between descriptive semantics (the words people use to describe something) and cognitive representations (which is basically the image or idea your mind makes up in your head (kind of like an abstract thought)) in evaluating evidence for judgments:

> Support Theory has an empirical base of results showing that different descriptions of the same event often produce different subjective probability estimates. It explains these results in terms of subjective evaluations of supporting evidence. It assumes that events are evaluated in terms of subjective evidence invoked by their descriptions, and that the observed numerical probability judgments are the result of the combining of such evaluations of support in a manner that is consistent with a particular equation. The processes of evaluation are assumed to employ heuristics like those of Kahneman and Tversky, and because of this, are subject to the kinds of biases introduced by such heuristics.
> This article provides a New Foundation for Support Theory. The New Foundation makes a sharp distinction between semantical representations of descriptions as part of natural language processing and cognitive representations of descriptions as part of a probabilistic judgment. In particular, judgments of probability employ a complementation operation that has no counterpart in the semantics. The complementation operation is used to construct cognitive events that are employed in the computation of the estimated probability.

So when someone evaluates a piece of information, they describe it in their mind (unconsciously or unconsciously) with words. Then they probably come to a conclusion from the evidence that the description provided.

[1] Simon, H. A. (1967). Motivational and emotional controls of cognition. Psychology Review, 74, 29-39.
[2] A New Foundation for Support Theory. (2004) Louis Narens. University of California, Irvine

So describing something with words would be something like, "Linda is a bank teller", or "Linda is a bank teller and is active in the feminist movement" Here is the explanation from Narens:

> Kahneman and Tversky found that over 85% of participants believed it was more likely that Linda was both a bank teller and a feminist than just a bank teller. This is an example of what has become known as the conjunction fallacy. According to Kahneman and Tversky, it is due to representativeness: "bank teller and is active in the feminist movement" is more a "representative" description of Linda than just "bank teller."

So a humans mind has the verbal description given to them in words, and then their mind forms a representation based off of what they heard (i.e. - possibly an idea of Linda in their minds).

So that means that there must be lots of words use people use to describe things, and also lots of cognitive 'ideas' or 'representations' they have in their mind that might assist these words.

So words, ideas and representations are all things a human's mind uses to think. I don't know when exactly a human mind might use words instead of abstract, non-verbal thoughts - that would be getting unnecessarily detailed into how thinking works, I would say.

2 So what exactly is a 'Subjective Evaluation'?

A subjective evaluation is exactly what those words describe - an assessment or evaluation of something that is biased, opinionated, and even possibly highly influenced by the persons feelings.

Subjective evaluations are important because people make them all of the time, whether or not they are aware of it. For instance anytime you see another person your mind makes an opinionated assessment of them. You might or might not be aware of your unconscious assessment - maybe you make a conscious assessment of the person that is different from your unconscious one, in which case you could feel confused about the person or something.

Since earlier in this paper I stated that everything in life is actually subjective, that means that people are constantly making subjective evaluations whenever they think about anything. Any thought about something could be subjective in some way.

If you see a photograph maybe you have an unconscious opinion of that - or even if you think about something you wouldn't typically consider to be emotional your mind could still have a strong unconscious feeling or interpretation.

3 How to develop a logical reasoner

The human mind (and animal minds, though the process is different) comes to conclusions by weighing evidence. This process could be done unconsciously or consciously; for instance people might make if - then statements to think about material. Part of that might be considering evidence from examples that easily come to mind (this is called the 'availability' heuristic), or examples that are harder or take longer to come to mind.

People often have a tendency to rely on the first piece of information gathered, this heuristic is called 'anchoring and adjustment' - During decision making, anchoring occurs when individuals use an initial piece of information to make subsequent judgments. People might adjust away from the anchor to get their final answer, which would be the logical thing to do; however studies show people tend rely on the first piece of information - whether it is right or not (instead of using it as evidence and explain away from it when the information is false)

So it depends on the cirumstance if people try or don't try to explain (adjust) away from an incorrect piece of evidence. They might try to justify the first piece of information offered (the anchor) even though it wouldn't be the logical thing to do.

So this relates to thinking logically - when weighing evidence, people need to consider if they are being falsely influenced by information and are biasing different pieces of information in their mind. They might

be biasing the first piece of information offered 'the anchor' and be relying too heavily on that instead of looking more objectively at all of the evidence.

So how exactly does the human mind weigh different pieces of information or construct an argument based off of evidence? It uses mental models to 'model' an argument, I would say. So there are different ways material or evidence can be considered by your mind, and these mental models weigh this evidence differently each time. Depending on the set of material or evidence, your mind might consider it differently (a 'mental model').

How could someone learn to reason more logically? I just explained two heuristics and how they effect thinking - by the speed and order of information made available to your mind. People bias the information they are given or don't consider it logically in many cases, but all that could be done about that to become a more logical thinker would be to be aware of your personal biases and be more reflective.

Hypothetical reasoning

What is hypothetical reasoning? It is creating imaginary worlds to test out our thinking. Here Stanovich [3] explains this type of reasoning in terms of carrying out goals, though I would say this type of thinking is critical for more complex thought as well:

> When we reason hypothetically, we create temporary models of the world and test out actions (or alternative causes) in that simulated world. In order to reason hypothetically we must, however, have one critical cognitive capability—the ability to distinguish our representations of the real world from representations of imaginary situations. For example, in considering an alternative goal state different from the one we currently have, we must be able to represent our current goal and the alternative goal and to keep straight which is which. Likewise, we need to be able to differentiate the representation of an action about to be taken from representations of potential alternative actions we are considering. But the latter must not infect the former while the mental simulation is being carried out.

If you think about it, humans must have a large imaginary world in their minds where they think and test out what they are thinking. This probably applies to everything - if you are trying to figure out which team is going to win a soccer match you might simulate the game in your head. If you are thinking about anything, you simulate the emotions, actions, behaviors, mathematical equations, or whatever it is - and this helps you think about it.

Heuristic vs. Rule-based processing

Heuristic processing is low-level, more unconscious and doesn't require as much thought as systematic processing. [4] Systematic processing requires active, careful scrutiny of relevant information and is more cognitively taxing.

Heuristic processing makes use of low-level decision rules such as 'analysts are always right' or 'statistics don't lie'. However, even though that type of processing makes use of rules, it is a lower-level processing than when rules are used by the systematic type of processing - which is more cognitive and leads to attitude change that is more enduring (because it is more conscious).

These different ways of processing are related to conscious and unconscious processing, or what is called in psychology a 'dual process theory' which provides an account of how a phenomenon can occur in two different ways, or as a result of two different processes. Often, the two processes consist of an implicit (automatic), unconscious process and an explicit (controlled), conscious process.

So rule-based processing usually refers to higher-level logic and casual inference. It follows rules, instead of merely conforming to them like how weight conforms to the law of gravity. So the unconscious could be considered to be doing its own thing, however the conscious mind actively thinks and therefore 'consciously' follows rules or thinks more about rules, more so than simply using a rule as a guideline. An example would be the rule-based decision rule example I used before to explain heuristic processing. If the rule or thought

[3] Stanovich, K. E., + Stanovich, P. J. (2010). A framework for critical thinking, rational thinking, and intelligence. In D. Preiss + R. J. Sternberg (Eds.), Innovations in educational psychology: Perspectives on learning, teaching and human development (pp. 195-237). New York: Springer.

[4] Chaiken, S. (1980). Heuristic Versus Systematic Information Processing and the Use of Source Versus Message Cues in Persuasion. Journal of Personality + Social Psychology, 39(5), 752-766. Retrieved from SocINDEX database.

is 'analysts are always right' then your mind might unconsciously follow that when listening to an analyst and then you would believe that he or she is right. However if the process is more conscious then you might think 'well maybe this person is wrong'. The rule wouldn't be as unconscious.

Anyone could really define 'heuristic processing' as being conscious or unconscious, controlled or automatic actually. Different people have termed the processes of the conscious mind and the processes of the unconscious mind differently - these are called 'dual process' theories. Here Moshman[5] lists all the combinations of the different types of processing as possibilities:

> Central to S+W's analysis is a distinction between automatic heuristic processing (characteristic of what they call System 1) and explicit rule-based processing (characteristic of what they call System 2). I believe this dichotomy confounds two orthogonal distinctions. Specifically, the distinction between automatic and explicit processing is conceptually orthogonal to the distinction between heuristic and rule-based processing. Crossing automatic versus explicit with heuristic versus rule-based suggests four possible types of processing: (a) automatic heuristic processing (System 1), (b) automatic rule-based processing (not represented in the Stanovich/West analysis), (c) explicit heuristic processing (also not represented), and (d) explicit rule-based processing (System 2).

The two types not represented probably weren't because they don't make complete sense - rule-based processing is more conscious and controlled, so saying it is automatic would be putting it in the unconscious category - which is possible, however that is not how it is defined. Explicit heuristic processing doesn't necessarily make much sense either because heuristic processing is defined as being automatic and not cognitively taxing, however explicit or controlled processes are cognitively taxing because they are more deliberate and conscious.

Conscious vs. unconscious intuitions

In the 'authors response' section of a Stanovich and West article (the same article as the previous quote (the Moshman commentary in that article)[6] the authors discuss the difference between intuitive feelings and ideas and conscious analytic analysis of people. In the article 'System 1' is more unconscious, forms intuitions, and the conscious mind then acquires these intuitions. They give the example of a statistics instructor who, though initially draws conclusions about students and infers probability about their personalities ('for whom the basic probability axioms are not transparent'), he or she eventually becomes no longer able to emphasize with them. Basically the unconscious, intuitive mind helps form our conscious understanding of people and of the probability judgments we make:

> We agree with Kahneman that some people may make more nuanced System 1 judgments than others, and that individual differences in this capability are of some importance. This is related to Teigen's point that when System 2 analytic abilities fail, well-framed intuitions may come to our assistance in narrowing the normative/descriptive gap, and the better those intuitions are the narrower the gap. But, following Reber (1992a; 1992b; 1993), we would conjecture that the variance in these System 1 abilities might well be considerably lower than the more recently evolved structures of System 2. Note, however, that this variability could become larger through the mechanism discussed above – instantiating of automatic System 1 algorithms through practice strategically initiated by System 2. Thus, some of the "well framed intuitions" referred to by Teigen may well be acquired intuitions – having their origins in capacity- intensive serial processing, yet now having the encapsulated, automatic characteristics of modular processes. Some statistics instructors, for example, become unable to empathize with their students for whom the basic probability axioms are not transparent. The instructor can no longer remember when these axioms were not primary intuitions.

[5]Diversity in reasoning and rationality: Metacognitive and developmental considerations. David Moshman. Commentary in Stanovich, K. E., + West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? Behavioral and Brain Sciences, 23, 645-665.

[6]Stanovich, K. E., + West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? Behavioral and Brain Sciences, 23, 645-665.

It is obvious that the unconscious mind helps forms our conscious understanding. People have two ways of thinking about the world, one is unconscious and one is conscious. These two systems must interact all of the time and influence each other in different ways.

Ways of thinking

The algorithmic level of analysis of mind is the level that just analyzes the details of what is occurring - it doesn't reflect and ask 'why' questions. There are different types of thinking dispositions, or ways people think - these ways of analyzing how someone thinks can help determine if a person is thinking rationally or irrationally. Here is Stanovich + Stanovich (2010):

> The difference between the algorithmic mind and the reflective mind is captured in another well-established distinction in the measurement of individual differences—the distinction between cognitive ability and thinking dispositions. The former are, as just mentioned, measures of the efficiency of the algorithmic mind. The latter travel under a variety of names in psychology—thinking dispositions or cognitive styles being the two most popular. Many thinking dispositions concern beliefs, belief structure and, importantly, attitudes toward forming and changing beliefs. Other thinking dispositions that have been identified concern a person's goals and goal hierarchy. Examples of some thinking dispositions that have been investigated by psychologists are: actively open-minded thinking, need for cognition (the tendency to think a lot), consideration of future consequences, need for closure, superstitious thinking, and dogmatism (Cacioppo, Petty, + Feinstein 1996; Kruglanski + Webster, 1996; Norris + Ennis, 1989; Schommer-Aikins, 2004; Stanovich, 1999, 2009; Sternberg, 2003; Sternberg + Grigorenko, 1997; Strathman, Gleicher, Boninger, + Scott Edwards, 1994).
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> The literature on these types of thinking dispositions is vast and our purpose is not to review that literature here. It is only necessary to note that the types of cognitive propensities that these thinking disposition measures reflect are the tendency to collect information before making up one's mind, to seek various points of view before coming to a conclusion, to think extensively about a problem before responding, to calibrate the degree of strength of one's opinion to the degree of evidence available, to think about future consequences before taking action, to explicitly weigh pluses and minuses of situations before making a decision, and to seek nuance and avoid absolutism. In short, individual differences in thinking dispositions include assessing variation in people's goal management, epistemic values, and epistemic self-regulation—differences in the operation of reflective mind. They are all psychological characteristics that underpin rational thought and action.

So there are bunch of subjective things a human's mind does that determine how it thinks. I mean in any single situation how could someone think about their entire 'goal hierarchy' or their 'belief structure'? Does that matter if the person is open-minded? How much do you need to think about the future consequences of your actions or weigh the pluses and minuses of a situation? All of these processes are very subjective and hard to measure on standard IQ tests; however they are all 'psychological characteristics that underpin rational thought and action'.

4 The Nature of Reasoning

Deductive reasoning is the same as top-down reasoning, where someone looks at generalizations first and then figures out what the details of those would be.

Often it could just be a guess what the details are since you might be inferring the details instead of finding evidence.

I would say that this type of logic can apply to any type of thinking. For instance, even if I am just moving the mouse of a computer I could think of it in two ways (deductive or inductive). The deductive way of thinking would be something like 'I am moving the mouse of the computer, my arm causes it to move and those are the movements it makes' and the inductive way would be 'these are the movements my computer mouse is making, I must be deciding to move the mouse - I am directing its movements'. With the deductive method, the idea of you came before the realization you were making detailed movements, and with the inductive method the opposite occurred.

My example is different from more obvious or straightforward examples of deductive and inductive reasoning, where it is clear what the generalization is and what the details are. I would say that it is still a good example, however, it is just more subjective. The idea 'I am moving the mouse' is the main idea, and the detail is 'the mouse is moving, those are the movements it is making'. The reason the movements of the mouse are the details is because that is where more description can be described.

That example of deductive reasoning is subjective, however. A more typical example would be one with a concretely broad idea and it would be clear that detail was inferred from it. With my example, however, you could say that the opposite is true and that the general idea is that 'the mouse is moving', and the detail is that 'I am moving the mouse' (instead of the opposite). It looks like it depends on which idea comes first. Whichever idea comes first the human mind would assess is the more generalized idea that needs to be supported. - That idea itself is significant because people could form delusions, or imagine what the details are or what the other side of the story is simply because they heard one idea first.