Review

The secret life of fluency

Daniel M. Oppenheimer

Princeton University, Department of Psychology, Green Hall, Princeton, NJ 08540, USA

Fluency – the subjective experience of ease or difficulty associated with completing a mental task – has been shown to be an influential cue in a wide array of judgments. Recently researchers have begun to look at how fluency impacts judgment through more subtle and indirect routes. Fluency impacts whether information is represented in working memory and what aspects of that information are attended to. Additionally, fluency has an impact in strategy selection; depending on how fluent information is, people engage in qualitatively different cognitive operations. This suggests that the role of fluency is more nuanced than previously believed and that understanding fluency could be of critical importance to understanding cognition more generally.

The secret life of fluency

When we make judgments, we have access to both external cues about the world and internal meta-cognitive cues about our own mental processes. Fluency – the subjective experience of ease or difficulty with which we are able to process information – is one of the most prominent meta-cognitive cues used in reasoning. People are aware of how difficult it is to process information, and knowledge of our ease of processing can lead to useful inferences about the external environment.

Because fluency is not a cognitive operation in and of itself but, rather, a feeling of ease associated with a cognitive operation, it can be generated by nearly any form of thinking. If a percept is blurry, we are aware that it was hard to see. If a word is phonemically irregular, we recognize the challenge in processing it. We know whether we had to struggle to bring a memory to mind and whether we had a hard or easy time solving a riddle. Because the metacognitive experience of fluency can be generated by so many cognitive processes and is nearly effortless to access [1], it can serve as a cue toward judgments in virtually any situation (see Box 1).

Indeed, fluency has been shown to have an influence on judgments across a wide array of domains. For example, people judge fluent statements to be more true [2,3], more likeable [4–6], more frequent [7,8], more famous [9], better category members [10,11] and to come from a more intelligent source [12] than disfluent statements (for a review, see [1]).

Fluency also can have an influence on choice. For example, Alter and Oppenheimer [13] showed that in the initial weeks after a company goes public, stocks with easier to pronounce names or ticker codes outperform stocks with more disfluent names or codes. That is, stocks from fluently named companies are judged to have higher values, and this perception of value drives purchasing decisions, which inflates the actual value of stocks. Similarly, Novemsky and his colleagues [14] have shown that when consumer products are made disfluent, consumers are more likely to defer choice or to choose a default option than when product names are fluently processed.

Obviously fluency can play a large role in judgment. However, the manner in which it does so can be surprisingly complex. Fluency can either act as a direct cue toward judgment or work through indirect pathways. Although the bulk of the research on fluency has investigated the former pathway, particularly regarding how fluency is interpreted (see Box 2), recent research has begun examining the indirect pathways: highlighting the role that fluency plays in influencing how information is represented and what operations are performed on those representations.

Fluency and representation

There are a variety of potentially useful cues that might be used to inform any given judgment – many more than can reasonably be represented given cognitive constraints [15]. Which cues are used and which are ignored? What information do we represent when making judgments?

Fluency could play a role in determining the answers to these questions. The idea that fluency is used as a mechanism for cue selection has recent empirical support [16–19]. In one set of studies, Day and Bartels [16] had participants make binary choices in which only one cue differentiated amongst options. For example, a large, inexpensive apartment in a good location was compared with a large, inexpensive apartment in a bad location. Because only one cue (location) distinguished between the options, that cue formed the basis of participants' choices. This led that cue to be salient and increased its fluency. In subsequent choices there were multiple attributes upon which the choices differed, but participants tended to rely heavily on the cue that had been made fluent because of previous use. Broder and Gaissmaier [17] also have suggested that retrieval fluency could be central in strategy selection.

In another set of studies, Shah and Oppenheimer [18] looked at linguistic fluency by providing participants with fictional Turkish stock indices with either fluent (e.g. Artan) or disfluent (e.g. Taahhut) names. People tended to put more weight on the fluent than disfluent cue, paying more attention to the ratings from the indices that had easier to pronounce names. In another study, Shah and Oppenheimer [18] explored perceptual fluency by providing participants with a set of cues with either a clear or blurred logo and demonstrated that participants weighted more fluent cues more heavily. Similarly, when cues were

Corresponding author: Oppenheimer, D.M. (doppenhe@princeton.edu).

 doi:10.1016/j.tics.2008.02.014

Box 1. The many faces of fluency

Fluency is defined as a subjective experience of ease or difficulty associated with a mental process. In other words, fluency isn't the process itself but, rather, information about how efficient or easy that process feels. Fluency effects can therefore be generated by nearly any form of cognitive processing, which makes it a difficult construct to pin down.

One approach to developing a concrete definition of fluency has been to equate the construct with reaction time. For example, Schooler and Hertwig [45] have operationalized retrieval fluency as the speed with which objects are recognized. This approach has the benefit of precision but has been criticized for being unable to account for the entire range of fluency effects. For example, facial feedback manipulations [46] such as having people furrow their brow can create the subjective experience of disfluency without slowing people's reaction times. In a related vein it is not clear how certain types of perceptual fluency, such as olfactory fluency [47] or gustatory fluency [48], could be effectively measured by using reaction times.

Another problem with this approach is that several influential fluency researchers have argued that fluency is best conceived of as the difference between expected difficulty and actual difficulty [49–51]. That is, the subjective experience of fluency depends critically upon the anticipation of difficulty. Measuring reaction time ignores this element of the fluency experience entirely.

An alternative approach to understanding fluency has been to use self reports of subjective difficulty. For example, Alter and Oppenheimer [13] measured phonetic fluency by asking subjects to rate how difficult it would be to pronounce different words aloud. Similarly, studies of perceptual fluency that use easy-to-read or difficult-to-read fonts typically have a norming study in which participants are shown different fonts in tandem and are asked to identify which are the easiest or hardest to read. Although this does have the benefit of being able to measure fluency across a wide spectrum of instantiations, it relies on self reports, which are notoriously unreliable [52].

Although it can be challenging to precisely define fluency effects, Alter and Oppenheimer, in an unpublished manuscript, have catalogued the various ways in which fluency has been operationalized and have developed a taxonomy of fluency effects. Types of observed fluency include: perceptual fluency, conceptual fluency, linguistic fluency, retrieval fluency, encoding fluency, embodied fluency, decision fluency, spatial fluency, deduction–based fluency, generative fluency and attentional fluency. In other words any type of cognitive process can feel easy or difficult to engage in, and this metacognitive information can be used in a number of ways.

Box 2. Attribution of fluency

Fluency is a natural cue for a variety of judgments because it correlates with so many things. Objects are fluent, for example, when they have been seen frequently, have been seen recently and/or have been seen for a long period of time. As a result, fluency is a useful cue for frequency, recency and duration of exposure. However, the fact that fluency is associated with many things and is, thus, useful in many domains also presents a challenge. With so many potential sources for fluency, it is difficult to know whether the fluency of a given object comes from a domain relevant to the dimension of judgment or if the fluency is owing to an irrelevant source.

In fact people do not use fluency blindly as a cue for judgment but attempt to attribute it to the appropriate source. This leads people to develop naive theories about the causes of their fluency experience and to apply fluency accordingly [1]. People's default attribution will be toward the domain of judgment. However, when there is an obvious alternative cause for fluency people will spontaneously discount the fluency experience, and the effects of fluency on judgment will be diminished or reversed [53]. For example, Oppenheimer [53] asked participants to judge the frequency of highly fluent surnames such as Bush, which were fluent because of fame rather than frequency. Participants reliably underestimated the frequency of such names because they attributed the fluency of the stimuli to fame rather than to frequency.

This attribution process can cause fluency to have diametrically opposing influences on judgment, depending on the context. For example, Brinol *et al.* [54] had participants read a paragraph priming either a positive or negative interpretation of fluency. They then manipulated the fluency of arguments regarding a new exam policy. When participants had been primed to think of fluency as a positive cue, more fluent arguments for a policy led to positive attitudes toward the policy. However, when participants were primed to think of fluency as a negative cue, increasing fluency led to more negative attitudes. Similarly, Unkelbach [55] created an artificial environment in which fluency was either correlated with previous exposure to a stimulus or to the novelty of a stimulus. Although participants were never explicitly instructed on the association between fluency and novelty, they nonetheless made subsequent judgments in line with the appropriate interpretation of fluency for their given environment.

Thus, the interpretation of a fluency experience relies on past experience and the current context, and depending on the interpretation, fluency can have very different influences on judgment.

written in a slightly degraded font, participants weighted the information less than when it was presented in an easier to process font.

These studies provide initial evidence that fluency itself not only serves as a cue in judgment but also helps in determining what other cues are used. Another way fluency can influence representation is by influencing what aspects of a cue people attend to. For example, the same stimulus often can be construed on a continuum from concrete (looking at specific details) to abstract (looking at global, higher order explanations). For example, going to the dentist can be construed abstractly as 'taking care of one's teeth' or concretely as 'being poked in the gums with sharp objects' [20]. Obviously, which aspects of the stimuli are attended to will yield different decisions about the desirability of a dentist visit.

One of the primary determinants of level of construal is the psychological distance of the stimulus; psychologically closer stimuli are construed more concretely [20]. Interestingly, disfluent objects are perceived to be more distant. For example, participants judge cities to be farther from their current location when the name of the city is printed in a difficult-to-read font than if it is printed in an easy-to-read font [21]. Because fluency influences psychological distance and psychological distance influences level of abstractness, the level of abstractness with which people construe information depends critically on the fluency of that information.

For example, Alter and Oppenheimer [21] prompted participants to describe New York City. For half of the participants, the prompt was written in a fluent font, whereas half were prompted in a disfluent font. Participants in the disfluent condition tended to describe New York more abstractly than those in the fluent condition. In a separate study the city of Los Angeles was made fluent to half of the participants through conceptual priming. Those participants who processed Los Angeles more fluently rated concrete descriptions of Los Angeles to be more apt than abstract descriptions, whereas the opposite was true of participants who processed Los Angeles disfluently.

In a final study Alter and Oppenheimer [21] examined the effect in a more naturalistic setting. They examined archival records for an online tournament of the game 'Balderdash'. In Balderdash each player fabricates a definition for an obscure English word, and other players attempt to guess which definitions are real and which are false. Alter and Oppenheimer [21] showed that players provided more abstract definitions for more phonemically complex words. Thus, the linguistic fluency of the word influenced the level of construal even outside the laboratory.

As evidenced by studies such as these, fluency can do more than have a direct influence on judgment. It can also indirectly influence judgments by changing what information we represent and the manner in which that information is represented. Another indirect pathway that has received attention recently involves the impact of fluency on what cognitive operations are performed on existing representations.

Fluency and operations

One theoretical framework that has garnered a great deal of attention is the dual-process approach to reasoning. Dual-process approaches assume that there are two distinct methods of reasoning. System 1 reasoning is heuristic, automatic, effortless and in parallel, whereas system 2 reasoning is analytic, deliberate, effortful and in serial [22]. In an insightful treatment of dual-process approaches, Jonathan Evans [23] has suggested a simple way of categorizing operations into the appropriate system: system 2 processes require working memory whereas system 1 processes do not.

Dual-process models have been popular in many areas of psychology including social psychology [24,25], cognitive psychology [26,27], judgment and decision making [22,28] and neuroscience [29,30]. Even researchers who dispute dual-process theories typically acknowledge that some forms of processing are slower and more deliberate than others [31,32]. One important question for cognitive psychologists is when are different processing strategies (i.e. cognitive operations) adopted?

Although most dual-process accounts propose that motivation and cognitive resources are the primary determinants of which system is used, recent evidence suggests that fluency could play a role as well [33,34]. To some extent the decision to adopt a more complex processing strategy could rely on one's confidence (or lack thereof) in the accuracy of a simpler strategy. Because fluency has been found to influence confidence judgments [35,36], it might therefore also influence strategy selection.

Alter *et al.* [33] have found strong evidence for this proposition. Participants took the Cognitive Reflection Test (CRT) [37], a psychometric tool to measure the extent to which an individual is engaging in heuristic (system 1) processing. The test consists of a number of items for which the 'gut instinct' is incorrect. For example, 'A bat and ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?' (Intuitive response: 10 cents. Correct response: 5 cents). However, people can use system 2 strategies to override their gut instinct and successfully solve the items.

Half of the participants took the test in a degraded (and therefore disfluent) font. The participants in the disfluent condition gave significantly more correct responses. In a second study participants were more likely to successfully answer difficult logical syllogisms when those syllogisms were presented in a disfluent rather than fluent font. This effect is particularly powerful in light of the fact that processing disfluent fonts imposes greater demands on cognitive resources than fluent fonts. Thus, participants were more successful at solving syllogisms despite being under mild cognitive load. This suggests that disfluency led participants to adopt a more systematic processing strategy.

However, by making the fonts harder to read, these manipulations almost certainly slowed participants down. An alternative explanation might be that the effects were due to increased time working on the task rather than disfluency *per se*. To get around this problem, Alter and his colleagues [33] used a different operationalization of fluency. Half of the participants were asked to furrow their brow as they completed the questions, a manipulation that has been shown to lead to a subjective impression of cognitive difficulty [38]. Participants experiencing disfluency through this facial feedback manipulation relied less on representativeness and more on base rates in answering the classic Tom W. base-rate fallacy problem [7]. Because the use of base rates requires system 2 reasoning, whereas representativeness is typically conceived of as a system 1 process [22], the probable reason for this improvement is that the lowered fluency caused participants to adopt a more effortful processing strategy. Importantly, unlike font manipulations, facial feedback does not slow participants, which suggests that fluency can have effects beyond merely forcing participants to spend longer on the task.

Song and Schwarz [34] provide convergent evidence for the role of fluency in strategy selection by investigating the Moses illusion. When people are asked how many animals of each kind Moses took on the ark, they typically answer 'two' despite the fact that it was Noah, not Moses, involved in the flood story. Song and Schwarz [34] found that participants were significantly more likely to detect the error when the question was written in a difficult-to-read font. This suggests that they were adopting a more systematic processing method and attending more carefully to the details of the question.

As such, it seems that fluency also plays a role in reasoning by influencing the strategies that people adopt.

Discussion

All of these findings point to the possibility that the effects of fluency are more complex than traditional accounts have suggested. Rather than being a straightforward positive cue toward judgment, fluency is interpreted through the lens of naive theories to determine whether and in what direction it should be considered (see Box 2). Additionally, fluency impacts judgment through several indirect pathways by influencing what information is represented, how it is represented and the operations performed on those representations (see Figure 1 for a schematic of how fluency impacts judgment).

This could explain some apparently contradictory findings in the fluency literature. For example, although some

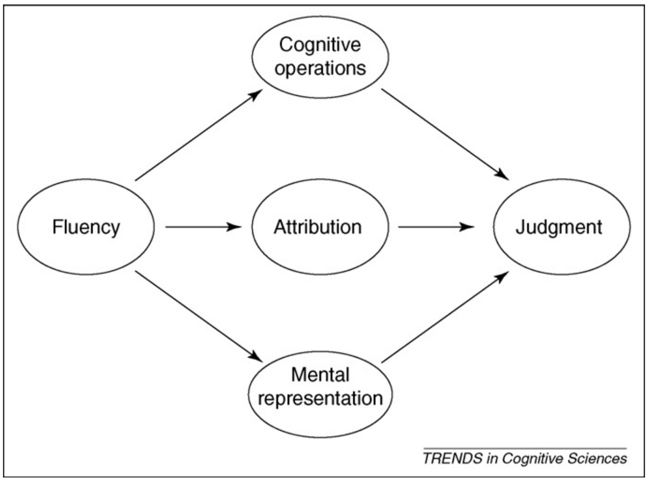

Figure 1. A comprehensive model of how fluency influences judgment. The direct use of fluency as a cue toward judgment is mediated by attributional processes (see Box 2). Additionally, fluency can influence judgment in more indirect ways by altering how information is represented and the operations that are performed on those representations. There could also be other indirect routes to judgment as well that have not yet been identified.

studies have shown that disfluency decreases people's confidence in their performance [35,36], other studies show that disfluency increases confidence [39]. Similarly, although some studies find that fluent stimuli are judged to be more familiar [40], other studies find that disfluent stimuli are judged to be more familiar [41]. Because of the many paths by which fluency can influence judgments, there can be competing forces generated by a single fluency experience that cancel each other out. Indeed, there could be other influences of fluency that have yet to be catalogued. For example, fluency could conceivably impact motivation or social desirability.

These findings also have important methodological implications. Stimuli presentation can vary in font or in the contrast between the figure and the ground, which can influence perceptual fluency. Instructions can vary in terms of phonemic or grammatical complexity, which can influence linguistic fluency and also can vary in how easy they are to remember, which can influence retrieval fluency. Because fluency impacts what information is represented and what operations are performed on those representations, one could conceivably obtain qualitatively different findings depending on the fluency of various aspects of an experiment. In other words, seemingly trivial decisions that researchers make when designing their studies can have nontrivial influences on their results. Researchers might, thus, wish to consider issues of fluency when developing experiments.

It is worth noting that there are a number of other internal cues aside from fluency that could work in very similar ways. For example, affect has been shown to influence judgment directly [42] as well as having a number of indirect influences on judgment [43]. Norbert Schwarz and his colleagues [44] have noted a number of parallels among moods, affect, embodied feedback and fluency. Their feelings as information approach suggests that the effects described in this paper might not only be limited to fluency, *per se* but also could extend to other internal cues. This could be a fruitful avenue for future research.

In addition to helping understand metacognition, these results also have important implications for cognition more generally. Of central concern to cognitive scientists are questions of what information we represent, how we represent that information and what cognitive operations are performed on those representations. The evidence presented here suggests that the answers to these questions depend critically on the extent to which a given experience is fluent or disfluent. People represent different information and perform qualitatively different operations on those representations depending on the fluency of the task. As such, understanding the role of metacognition is a critical step to any general model of cognition.

References

1 Schwarz, N. (2004) Metacognitive experiences in consumer judgment and decision making. *J. Consum. Psychol.* 14, 332–348
2 McGlone, M.S. and Tofighbakhsh, J. (2000) Birds of a feather flock conjointly(?): rhyme as reason in aphorisms. *Psychol. Sci.* 11, 424–428
3 Reber, R. and Schwarz, N. (1999) Effects of perceptual fluency on judgments of truth. *Conscious. Cogn.* 8, 338–342
4 Bornstein, R.F. and D'Agostino, P.R. (1992) Stimulus recognition and the mere exposure effect. *J. Pers. Soc. Psychol.* 63, 545–552
5 Reber, R. *et al.* (1998) Effects of perceptual fluency on affective judgments. *Psychol. Sci.* 9, 45–48
6 Zajonc, R.B. (1968) Attitudinal effects of mere exposure. *J. Pers. Soc. Psychol.* 9, 1–27
7 Kahneman, D. and Tversky, A. (1973) On the psychology of prediction. *Psychol. Rev.* 80, 237–257
8 Schwarz, N. *et al.* (1991) Ease of retrieval as information: another look at the availability heuristic. *J. Pers. Soc. Psychol.* 61, 195–202
9 Jacoby, L.L. *et al.* (1989) Becoming famous without being recognized: unconscious influences of memory produced by dividing attention. *J. Exp. Psychol. Gen.* 118, 115–125
10 Oppenheimer, D.M. and Frank, M.F. (2007) A rose in any other font would not smell as sweet: effects of perceptual fluency on categorization. *Cognition* 106, 1178–1194
11 Whittlesea, B.W.A. and Leboe, J.P. (2000) The heuristic basis of remembering and classification: fluency, generation, and resemblance. *J. Exp. Psychol. Gen.* 129, 84–106
12 Oppenheimer, D.M. (2006) Consequences of erudite vernacular utilized irrespective of necessity: problems with using long words needlessly. *Appl. Cogn. Psychol.* 20, 139–156
13 Alter, A.L. and Oppenheimer, D.M. (2006) Predicting short-term stock fluctuations by using processing fluency. *Proc. Natl. Acad. Sci. U. S. A.* 103, 9369–9372
14 Novemsky, N. *et al.* (2007) Preference fluency in choice. *J. Mark. Res.* 44, 347–356
15 Simon, H.A. (1990) Invariants of human behavior. *Annu. Rev. Psychol.* 41, 1–19
16 Day, S.B. and Bartels, D.M. (2005) The effects of prior use on preference. In *Proceedings of the 27th Annual Meeting of the Cognitive Science Society, CogSci2005*. July 22; *Hillsdale*: Lawrence Erlbaum Associates; 2005: 553–558
17 Bröder, A. and Gaissmaier, W. (2007) Sequential processing of cues in memory-based multiattribute decisions. *Psychon. Bull. Rev.* 14, 895–900
18 Shah, A.K. and Oppenheimer, D.M. (2007) Easy does it: The role of fluency in cue weighting. *Judgment and Decision Making* 2, 371–379
19 Shah, A.K. and Oppenheimer, D.M. (2008) Heuristics made easy: an effort reduction framework of heuristic judgment. *Psychol. Bull.* 134, 2007–2022
20 Trope, Y. and Liberman, N. (2003) Temporal construal. *Psychol. Rev.* 110, 401–421
21 Alter, A.L. and Oppenheimer, D.M. (2008) Effects of fluency on psychological distance and mental construal (or why New York is a large city, but *New York* is a civilized jungle). *Psychol. Sci.* 19, 161–167
22 Kahneman, D. and Frederick, S. (2002) Representativeness revisited: attribute substitution in intuitive judgment. In *Heuristics and Biases* (Gilovich, T., Griffin, D. and Kahneman, D., eds), pp. 49–81, Cambridge University Press

23 Evans, J.S.B.T. (2007) *Hypothetical Thinking: Dual Processes in Reasoning and Judgement.* Psychology Press
24 Chaiken, S. (1980) Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *J. Pers. Soc. Psychol.* 39, 752–766
25 Petty, R.E. and Cacioppo, J.T. (1986) *The Elaboration Likelihood Model of Persuasion.* Academic Press
26 Evans, J.S.B.T. and Over, D.E. (1996) *Rationality and Reasoning.* Psychology Press
27 Sloman, S.A. (1996) The empirical case for two systems of reasoning. *Psychol. Bull.* 119, 3–22
28 Stanovich, K.E. and West, R.F. (2000) Individual differences in reasoning: implications for the rationality debate? In *Heuristics and Biases* (Gilovich, T., Griffin, D. and Kahneman, D., eds), pp. 421–440, Cambridge University Press
29 Botvinick, M.M. *et al.* (2001) Conflict monitoring and cognitive control. *Psychol. Rev.* 108, 624–652
30 Lieberman, M.D. *et al.* (2002) Reflections and reflexion: a social cognitive neuroscience approach to attributional inference. In *Advances in Experimental Social Psychology* (Vol. 34) (Zanna, M.P., ed.), In pp. 199–249, Academic Press
31 Kruglanski, A.W. and Thompson, E.P. (1999) Persuasion by a single route: a view from the unimodel. *Psychol. Inq.* 10, 83–109
32 Osman, M. (2004) An evaluation of dual-process theories of reasoning. *Psychon. Bull. Rev.* 11, 988–1010
33 Alter, A.L. *et al.* (2007) Overcoming intuition: metacognitive difficulty activates analytic reasoning. *J. Exp. Psychol. Gen.* 136, 569–576
34 Song, H. and Schwarz, N. Fluency and the detection of misleading questions: low processing fluency attenuates the Moses illusion. *Soc. Cogn*. (in press)
35 Kelley, C.M. and Lindsay, S.D. (1993) Remembering mistaken for knowing: ease of retrieval as a basis for confidence in answers to general knowledge questions. *J. Mem. Lang.* 32, 1–24
36 Koriat, A. (1993) How do we know that we know? The accessibility model of the feeling of knowing. *Psychol. Rev.* 100, 609–639
37 Frederick, S. (2005) Cognitive reflection and decision making. *J. Econ. Perspect.* 19, 25–42
38 Stepper, S. and Strack, F. (1993) Proprioceptive determinants of affective and nonaffective feelings. *J. Pers. Soc. Psychol.* 64, 211–220
39 Watkins, C.L. (1988) The revelation effect: when disguising test items induces recognition. *J. Exp. Psychol. Learn. Mem. Cogn.* 16, 1012–1020
40 Monin, B. (2003) The warm glow heuristic: when liking leads to familiarity. *J. Pers. Soc. Psychol.* 85, 1035–1048
41 Guttentag, R. and Dunn, J. (2003) Judgments of remembering: the revelation effect in children and adults. *J. Exp. Child Psychol.* 86, 153–167
42 Finucane, M.L. *et al.* (2000) The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making* 13, 1–17
43 Forgas, J.P. (1995) Mood and judgment: the affect infusion model (AIM). *Psychol. Bull.* 117, 39–66
44 Schwarz, N. and Clore, G.L. (2007) Feelings and phenomenal experiences. In *Social Psychology. Handbook of Basic Principles* (2nd edn) (Kruglanski, A. and Higgins, E.T., eds), pp. 385–407, Guilford
45 Schooler, L.J. and Hertwig, R. (2005) How forgetting aids heuristic inference. *Psychol. Rev.* 112, 610–628
46 Tourangeau, R. and Ellsworth, P. (1979) The role of the face in the experience of emotion. *J. Pers. Soc. Psychol.* 37, 1519–1531
47 Balogh, R.D. and Porter, R.H. (1986) Olfactory preferences resulting from mere exposure in human neonates. *Infant Behav. Dev.* 9, 395–401
48 Pliner, P. (1982) The effects of mere exposure on liking for edible substances. *Appetite* 3, 283–290
49 Whittlesea, B.W.A. and Williams, L.D. (1998) Why do strangers feel familiar, but friends don't? The unexpected basis of feelings of familiarity. *Acta Psychol (Amst.)* 98, 141–166
50 Whittlesea, B.W.A. and Williams, L.D. (2001) The discrepancy-attribution hypothesis I: the heuristic basis of feelings of familiarity. *J. Exp. Psychol. Learn. Mem. Cogn.* 27, 3–13
51 Whittlesea, B.W.A. and Williams, L.D. (2001) The discrepancy-attribution hypothesis II: expectation, uncertainty, surprise and feelings of familiarity. *J. Exp. Psychol. Learn. Mem. Cogn.* 27, 14–33
52 Nisbett, R.E. and Wilson, T.D. (1977) Telling more than we can know: verbal reports on mental processes. *Psychol. Rev.* 84, 231–259
53 Oppenheimer, D.M. (2004) Spontaneous discounting of availability in frequency judgment tasks. *Psychol. Sci.* 15, 100–105
54 Briñol, P. *et al.* (2006) The meaning of subjective ease and its malleability. *Psychol. Sci.* 17, 200–206
55 Unkelbach, C. (2006) The learned interpretation of cognitive fluency. *Psychol. Sci.* 17, 339–345