Priming (psychology)

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Priming is an implicit memory effect in which exposure to one stimulus (i.e., perceptual pattern) influences the response to another stimulus. The seminal experiments of Meyer and Schvaneveldt in the early 1970s[1][2][3] led to the flowering of research on priming of many sorts. Their original work showed that people were faster in deciding that a string of letters is a word when the word followed an associatively or semantically related word. For example, `NURSE` is recognized more quickly following `DOCTOR` than following `BREAD`. Various experiments[2][3] supported the theory that activation spreading among related ideas was the best explanation for the facilitation observed in the lexical decision task. The priming paradigm provides excellent control over the effects of individual stimuli on cognitive processing and associated behavior because the same target stimuli can be presented with different primes. Thus differences in performance as a function of differences in priming stimuli must be attributed to the effect of the prime on the processing of the target stimulus.

Priming can occur following perceptual, semantic, or conceptual stimulus repetition. For example, if a person reads a list of words including the word *table*, and is later asked to complete a word starting with *tab*, the probability that he or she will answer *table* is greater than if they are not primed. Another example is if people see an incomplete sketch they are unable to identify and they are shown more of the sketch until they recognize the picture, later they will identify the sketch at an earlier stage than was possible for them the first time.[4]

The effects of priming can be very salient and long lasting, even more so than simple recognition memory.[5] Unconscious priming effects can affect word choice on a word-stem completion test long after the words have been consciously forgotten.[5]

Priming works best when the two stimuli are in the same modality. For example, visual priming works best with visual cues and verbal priming works best with verbal cues. But priming also occurs between modalities,[6] or between semantically related words such as "doctor" and "nurse".[1][7]

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Types

Positive and negative priming

The terms *positive* and *negative* priming refer to when priming affects the speed of processing. A positive prime speeds up processing, while a negative prime lowers the speed to slower than un-primed levels.[8] Positive priming is caused by simply experiencing the stimulus,[9] while negative priming is caused by experiencing the stimulus, and then ignoring it.[8][10] Positive priming effects happen even if the prime is not consciously seen.[9] The effects of positive and negative priming are visible in event-related potential (ERP) readings.[11]

Positive priming is thought to be caused by spreading activation.[9] This means that the first stimulus activates parts of a particular representation or association in memory just before carrying out an action or task. The representation is already partially activated when the second stimulus is encountered, so less additional activation is needed for one to become consciously aware of it.

Negative priming is more difficult to explain. Many models have been hypothesized, but currently the most widely accepted are the distractor inhibition and episodic retrieval models.[8] In the distractor inhibition model, the activation of ignored stimuli is inhibited by the brain.[8] The episodic retrieval model hypothesizes that ignored items are flagged 'do-not-respond' by the brain. Later, when the brain acts to retrieve this information, the tag causes a conflict. The time taken to resolve this conflict causes negative priming.[8] Although both models are still valid, recent scientific research has led scientists to lean away from the distractor inhibitor model.[8]

Perceptual and conceptual priming

The difference between *perceptual* and *conceptual* primes is whether items with a similar *form* or items with a similar *meaning* are primed, respectively.

Perceptual priming is based on the form of the stimulus and is enhanced by the match between the early and later stimuli. Perceptual priming is sensitive to the modality and exact format of the stimulus. An example of perceptual priming is the identification of an incomplete word in a word-stem completion test. The presentation of the visual prime does not have to be perfectly consistent with later testing presentations in order to work. Studies have shown that, for example, the absolute size of the stimuli can vary and still provide significant evidence of priming.[12]

Conceptual priming is based on the meaning of a stimulus and is enhanced by semantic tasks. For example, *table*, will show priming effects on *chair*, because *table* and *chair* belong to the same category.[13]

Repetition

Repetition priming, also called *direct priming*, is a form of positive priming. When a stimulus is experienced, it is also primed. This means that later experiences of the stimulus will be processed more quickly by the brain.[14] This effect has been found on words in the lexical decision task.

Semantic

In *semantic priming*, the prime and the target are from the same semantic category and share features.[15] For example, the word *dog* is a semantic prime for *wolf*, because the two are both similar animals. Semantic priming is theorized to work because of spreading activation within associative networks.[9] When a person thinks of one item in a category, similar items are stimulated by the brain. Even if they are not words, morphemes can prime for complete words that include them.[16] An example of this would be that the morpheme 'psych' can prime for the word 'psychology'.

Associative priming

In *associative priming*, the target is a word that has a high probability of appearing with the prime, and is "associated"

with it but not necessarily related in semantic features. *dog* is an associative prime for *cat*, since the words are closely associated and frequently appear together (in phrases like "raining cats and dogs").[17] A similar effect is known as *context priming*. Context priming works by using a context to speed up processing for stimuli that are likely to occur in that context. A useful application of this effect is reading written text.[18] The grammar and vocabulary of the sentence provide contextual clues for words that will occur later in the sentence. These later words are processed more quickly than if they had been read alone, and the effect is greater for more difficult or uncommon words.[18]

Response priming

In the psychology of visual perception and motor control, the term *response priming* denotes a special form of visuomotor priming effect. The distinctive feature of response priming is that prime and target are presented in quick succession (typically, less than 100 milliseconds apart) and are coupled to identical or alternative motor responses.[19][20] When a speeded motor response is performed to classify the target stimulus, a prime immediately preceding the target can thus induce response conflicts when assigned to a different response as the target. These response conflicts have observable effects on motor behavior, leading to priming effects, e.g., in response times and error rates. A special property of response priming is its independence from visual awareness of the prime: For example, response priming effects can increase under conditions where visual awareness of the prime is decreasing.[21][22]

Masked priming

The masked priming paradigm has been widely used in the last two decades in order to investigate both orthographic and phonological activations during visual word recognition. The term "masked" refers to the fact that the prime word or pseudoword is masked by symbols such as ###### that can be presented in a forward manner (before the prime) or a backward manner (after the prime). These masks enable to diminish the visibility of the prime. The prime is usually presented less than 80 ms (but typically between 40-60 ms) in this paradigm. In all, the short SOA (Stimuli Onset Asynchrony, i.e. the time delay between the onset of the mask and the prime) associated with the masking make the masked priming paradigm a good tool to investigate automatic and irrepressive activations during visual word recognition.[23] Forster has argued that masked priming is a purer form of priming, as any conscious appreciation of the relationship between the prime and the target is effectively eliminated, and thus removes the subject's ability to use the prime strategically to make decisions. Results from numerous experiments show that certain forms of priming occur that are very difficult to occur with visible primes. One such example is form-priming, where the prime is similar to, but not identical to the target (e.g., *nature-mature*).[24][25]

Kindness priming

Kindness priming is a specific form of priming that occurs when a subject experiences an act of kindness and subsequently experiences a lower threshold of activation when subsequently encountering positive stimuli. A unique feature of kindness priming is that it causes a temporary increased resistance to negative stimuli in addition to the increased activation of positive associative networks.[26]

Measuring the effects of priming

Priming effects can be found with many of the tests of implicit memory. Tests such as the word-stem completion task, and the word fragment completion task measure perceptual priming. In the word-stem completion task, participants are given a list of study words, and then asked to complete word "stems" consisting of 3 letters with the first word that comes to mind. A priming effect is observed when participants complete stems with words on the study list more often than with novel words. The word fragment completion task is similar, but instead of being given the stem of a word, participants are given a word with some letters missing. The lexical decision task can be used to demonstrate conceptual priming.[1][2] In this task, participants are asked to determine if a given string is a word or a nonword. Priming is demonstrated when participants are quicker to respond to words that have been primed with semantically-related words, e.g., faster to confirm "nurse" as a word when it is preceded by "doctor" than when it is preceded by "butter". Other evidence has been found through brain imaging and studies from brain injured patients.

Effects of brain injuries

Amnesia

Amnesic patients are described as those who have suffered damage to their medial temporal lobe, resulting in the impairment of explicit recollection of everyday facts and events. Priming studies on amnesic patients have varying results, depending on both the type of priming test done, as well as the phrasing of the instructions.

Amnesic patients do as well on *perceptual priming* tasks as healthy patients,[27] however they show some difficulties completing *conceptual priming* tasks, depending on the specific test. For example, they perform normally on category instance production tasks, but show impaired priming on any task that involves answering general knowledge questions.[28][29]

Phrasing of the instructions associated with the test has had a dramatic impact on an amnesic's ability to complete the task successfully. When performing a word-stem completion test, patients were able to successfully complete the task when asked to complete the stem using the first word that came to mind, but when explicitly asked to recall a word to complete the stem that was on the study list, patients performed at below-average levels.[30]

Overall, studies from amnesic patients indicate that priming is controlled by a brain system separate from the medial temporal system that supports explicit memory.

Aphasia

Perhaps the first use of semantic priming in neurological patients was with stroke patients with aphasia. In one study, patients with Wernicke's aphasia who were unable to make semantic judgments showed evidence of semantic priming, while patient with Broca's aphasia who were able to make semantic judgments showed less consistent priming than Wernicke's aphasics or normal controls (Milberg and Blumstein 1981). This dissociation was extended to other linguistic categories such phonology and syntactic processing by Blumstein, Milberg and their colleagues.

Dementia

Patients with Alzheimer's disease (AD), the most common form of dementia, have been studied extensively as far as priming goes. Results are conflicting in some cases, but overall, AD patients show *decreased* priming effects on word-stem completion and free association tasks, while retaining normal performance on lexical decision tasks.[31] These results suggest that AD patients are impaired in any sort of priming task that requires semantic processing of the stimuli, while priming tasks that require visuoperceptual interpretation of stimuli are unaffected by Alzheimers.

Focal cortical lesions

Patient J.P., who suffered a stroke in the left medial/temporal gyrus, resulting in auditory verbal agnosia – the inability to comprehend spoken words, but maintaining the ability to read and write, and with no effects to hearing ability. J.P. showed normal perceptual priming, but his conceptual priming ability for spoken words was, expectedly, impaired.[32] Another patient, N.G., who suffered from **prosopanomia** (the inability to retrieve proper names) following damage to his left temporal lobe, was unable to spontaneously provide names of persons or cities, but was able to successfully complete a word-fragment completion exercise following priming with these names. This demonstrated intact perceptual priming abilities.[33]

Cognitive neuroscience

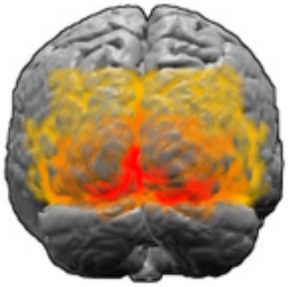
Perceptual priming

Priming while improving performance decreases neural processing in the cerebral cortex of sensory stimuli with stimulus repetition. This has been found in single-cell recordings[34] and in electroencephalography (EEG) upon gamma waves,[35] with PET[36] and functional MRI.[37] This reduction is due to representational sharpening in the early sensory areas which reduces the number of neurons representing the stimulus. This leads to a more selective activation of neurons representing objects in higher cognitive areas.[38]

Conceptual priming

Conceptual priming has been linked to reduced blood flow in the left prefrontal cortex.[39] The left prefrontal cortex is believed to be involved in the semantic processing of words, among other tasks.[40]

The view that perceptual priming is controlled by the extrastriate cortex while conceptual priming is controlled by the left prefrontal cortex is undoubtedly an oversimplified view of the process, and current work is focused on elucidating the brain regions involved in priming in more detail.[41]



The extrastriate cortex (shown in orange and red) is believed to be involved in perceptual priming

In daily life

Priming is thought to play a large part in the systems of stereotyping. [42] This is because attention to a response increases the frequency of that response, even if the attended response is undesired. [42][43] The attention given to these response or behaviours primes them for later activation.[42] Another way to explain this process is automaticity. If trait descriptions, for instance "stupid" or "friendly", have been frequently or recently used, these descriptions can be automatically used to interpret someone's behavior. An individual is unaware of this, and this may lead to behavior that may not agree with their personal beliefs.[44]

This can occur even if the subject is not conscious of the priming stimulus.[42] An example of this was done by Bargh et al. in 1996. Subjects were implicitly primed with words related to the stereotype of elderly people (example: Florida, forgetful, wrinkle). While the words did not explicitly mention speed or slowness, those who were primed with these words walked more slowly upon exiting the testing booth than those who were primed with neutral stimuli.[42] Similar effects were found with rude and polite stimuli: those primed with rude words were more likely to interrupt an investigator than those primed with neutral words, and those primed with polite words were the least likely to interrupt.[42] A Yale study showed that something as simple as holding a hot or cold beverage before an interview could result in pleasant or negative opinion of the interviewer.[45] However, there has been a serious lack of replication (see below).

These findings have been extended to therapeutic interventions. For example, Cox et al. (2012) suggest that presented with a depressed patient who "self-stereotypes herself as incompetent, a therapist can find ways to prime her with specific situations in which she had been competent in the past... Making memories of her competence more salient should reduce her self-stereotype of incompetence."[46]

The replicability and interpretation of goal-priming findings has become controversial.[47] Recent studies have failed to replicate findings, including age priming,[48] with additional reports of failure to replicate this and other findings such as social-distance also reported.[49][50]

Criticism

Although semantic, associative, and form priming are well established, some longer-term priming effects were not replicated in further studies, casting doubt on their effectiveness or even existence.[51] Nobel laureate and psychologist Daniel Kahneman has called on priming researchers to check the robustness of their findings in an open letter to the community, claiming that priming has become a "*poster child for doubts about the integrity of psychological research.*"[52] Other critics have asserted that priming studies suffer from major publication bias,[53] experimenter effect[48] and that criticism of the field is not dealt with constructively.[54]

See also

- Intertrial priming

References

1. Meyer, D.E.; Schvaneveldt, R.W. (1971). "Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations". *Journal of Experimental Psychology*. **90**: 227–234. doi:10.1037/h0031564.
2. Schvaneveldt, R.W.; Meyer, D.E. (1973), "Retrieval and comparison processes in semantic memory", in Kornblum, S., *Attention and performance IV*, New York: Academic Press, pp. 395–409
3. Meyer, D.E.; Schvaneveldt, R.W.; Ruddy, M.G. (1975), "Loci of contextual effects on visual word recognition", in Rabbitt, P.; Dornic, S., *Attention and performance V*, London: Academic Press, pp. 98–118
4. Kolb & Whishaw: *Fundamentals of Human Neuropsychology* (2003), page 453-454, 457.
5. Tulving, Endel; Schacter, Daniel L.; Stark, Heather A. (1982). "Priming Effects in Word Fragment Completion are independent of Recognition Memory". *Journal of Experimental Psychology: Learning, Memory and Cognition*. **8** (4).
6. Several researchers, for example, have used cross-modal priming to investigate syntactic deficits in individuals with damage to Broca's area of the brain. See the following:
    - Zurif E, Swinney D, Prather P, Solomon J, Bushell C (1993). "An on-line analysis of syntactic processing in Broca's and Wernicke's aphasia". *Brain and Language*. **45** (3): 448–464. doi:10.1006/brln.1993.1054. PMID 8269334.
    - Swinney, D., E. Zurif, P. Prather, and T. Love (1993). "The neurological distribution of processing operations underlying language comprehension." Manuscript, Department of Psychology, University of California, San Diego.
    - For an overview, see also Zurif, E.B. (1995), "Brain Regions of Relevance to Syntactic Processing." in *Knowledge of Meaning: An Introduction to Semantic Theory*, eds. Richard Larson and Gabriel Segal. MIT Press.
7. Friederici, Angela D.; Steinhauer, Karsten; Frisch, Stefan (1999). "Lexical integration: Sequential effects of syntactic and semantic information". *Memory & Cognition*. **27** (3): 438–453. doi:10.3758/BF03211539. "*Semantic priming* refers to the finding that word recognition is typically faster when the target word (e.g., *doctor*) is preceded by a semantically related prime word (e.g., *nurse*)."
8. Mayr, Susanne; Buchner, Axel (2007). "Negative Priming as a Memory Phenomenon: A Review of 20 Years of Negative Priming Research". *Journal of Psychology*. **215** (1): 35–51. doi:10.1027/0044-3409.215.1.35.
9. Reisberg, Daniel: *Cognition: Exploring the Science of the Mind* (2007), page 255, 517.
10. Neumann, Ewald; DeSchepper, Brett G. (1991). "Costs and Benefits of Target Activation and Distractor Inhibition in Selective Attention". *Journal of Experimental Psychology: Learning, Memory, and Cognition*. **17**: 1136–1145. doi:10.1037/0278-7393.17.6.1136.
11. Bentin, Shlomo; McCarthy, Gregory; Wood, Charles C. (1985). "Event Related Potentials, Lexical Decision and Semantic Priming". *Electroencephalography and Clinical Neurophysiology*. **60**.
12. Biederman, Irving; Cooper, Eric E. (1992). "Size Invariance in Visual Object Priming". *Journal of Experimental Psychology: Human Perception and Performance*. **18** (1): 121–133. doi:10.1037/0096-1523.18.1.121.
13. Vaidya, Chandan L.; Monti, Laura A.; Gabrieli, John D.E.; Tinklenburg, Jared R.; Yesevage, Jerome A. (1999). "Dissociation between two forms of conceptual priming in Alzheimer's disease" (PDF). *Neuropsychology*. **13** (4): 516–24. doi:10.1037/0894-4105.13.4.516. PMID 10527059.
14. Forster, Kenneth I.; Davis, Chris (1984). "Repetition Priming and Frequency Attenuation". *Journal of Experimental Psychology: Learning, Memory and Cognition*. **10** (4).
15. Ludovic Ferrand and Boris New: Semantic and associative priming in the mental lexicon, found on: boris.new.googlepages.com/Semantic-final-2003.pdf
16. Marslen-Wilson, William; Tyler, Lorraine Komisarjevsky; Waksler, Rachelle (1994). "Morphology and Meaning in the English Mental Lexicon". *Psychological Review*. **101** (1): 3–33. doi:10.1037/0033-295x.101.1.3.
17. Matsukawa, Junko; Snodgrass, Joan Gay; Doniger, Glen M. (2005). "Conceptual versus perceptual priming in incomplete picture identification". *Journal of Psycholinguistic Research*. **34** (6).
18. Stanovich, Keith E.; West, Richard F. (1983). "On Priming by a Sentence Context". *Journal of Experimental Psychology*. **112** (1): 1–36. doi:10.1037/0096-3445.112.1.1.
19. Klotz, W.; Wolff, P. (1995). "The effect of a masked stimulus on the response to the masking stimulus.". *Psychological Research*. **58**: 92–101. doi:10.1007/bf00571098.
20. Klotz, W.; Neumann, O. (1999). "Motor activation without conscious discrimination in metacontrast masking.". *Journal of Experimental Psychology: Human Perception and Performance*. **25**: 976–992. doi:10.1037/0096-1523.25.4.976.
21. Vorberg, D., Mattler, U., Heinecke, A., Schmidt, T., & Schwarzbach, J. *Different time courses for visual perception and action priming.* In: *Proceedings of the National Academy of Sciences USA*, 100, 2003, p. 6275-6280.
22. Schmidt, T., & Vorberg, D. *Criteria for unconscious cognition: Three types of dissociation.* In: *Perception & Psychophysics*, 68, 2006, p. 489-504.
23. Forster, K.I.; Davis, C. (1984). "Repetition priming and frequency attenuation in lexical decision". *Journal of Experimental Psychology: Learning, Memory, and Cognition*. **10** (4): 680–698. doi:10.1037/0278-7393.10.4.680.
24. Forster, K.I.; Davis, C. (1984). "The density constraint on form-priming in the naming task: Interference effects from a masked prime". *Journal of Memory and Language*. **30** (1): 1–25. doi:10.1016/0749-596X(91)90008-8.
25. Forster, K.I.; Davis, C.; Schoknecht, C.; Carter, R. (1987). "Masked priming with graphemically related forms: Repetition or partial activation?". *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology*. **39A** (2): 211–251. doi:10.1080/14640748708401785.
26. Carlson, Charlin, Norman, http://psycnet.apa.org/journals/psp/55/2/211/, Positive mood and helping behavior: A test of six hypotheses, 1989

27. Cermak, L.S.; Talbot, N.; Chandler, K.; Wolbarst, L.R. (1985). "The perceptual priming phenomenon in amnesia". *Neuropsychologia*. **23** (5): 615–622. doi:10.1016/0028-3932(85)90063-6. PMID 4058707.
28. Shimamura, A.P.; Squire, L.R. (1984). "Paired-associate learning and priming effects in amnesia: a neuropsychological approach". *J. Exp. Psychol.* **113**: 556–570.
29. Blaxton, T.A. (1992). "Dissociations among memory measures in memory-impaired subjects: evidence for a processing account of memory". *Mem. Cogn.* **15**: 549–562.
30. Graf, P.; Squire, L.R.; Mandler, G. (1984). "The information that amnesic patients do not forget". *J. Exp. Psychol.* **10**: 164–178. doi:10.1037/0278-7393.10.1.164.
31. Carlesimo, G.A.; Oscarberman, M. (1992). "Memory deficits in Alzheimer's patients: a comprehensive review". *Neuropsychology Review*. **3** (2): 119–169. doi:10.1007/BF01108841. PMID 1300219.
32. Schacter, D.L.; McGlynn, S.M.; Milberg, W.P.; Church, B.A. (1993). "Spared priming despite impaired comprehension: implicit memory in a case of word meaning deafness". *Neuropsychology*. **7** (2): 107–118. doi:10.1037/0894-4105.7.2.107.
33. Geva, A.; Moscovitch, M.; Leach, L. (1997). "Perceptual priming of proper names in young and older normal adults and a patient with prosopanomia". *Neuropsychology*. **11** (2): 232–242. doi:10.1037/0894-4105.11.2.232. PMID 9110330.
34. Li L, Miller EK, Desimone R (1993). "The representation of stimulus familiarity in anterior inferior temporal cortex". *J Neurophysiol.* **69** (6): 1918–29. PMID 8350131.
35. Gruber, T; Müller, MM (2002). "Effects of picture repetition on induced gamma band responses, evoked potentials, and phase synchrony in the human EEG". *Brain research. Cognitive brain research.* **13** (3): 377–92. doi:10.1016/S0926-6410(01)00130-6. PMID 11919002.
36. Squire, L.R.; Ojemann, J.G.; Miezin, F.M.; Petersen, S.E.; Videen, T.O.; Raichle, M.E. (1992). "Activation of the hippocampus in normal humans: a functional anatomical study of memory". *Proc. Natl. Acad. Sci. USA.* **89** (5): 1837–1841. doi:10.1073/pnas.89.5.1837. PMC 48548. PMID 1542680.
37. Wig, GS; Grafton, ST; Demos, KE; Kelley, WM (2005). "Reductions in neural activity underlie behavioral components of repetition priming". *Nature Neuroscience*. **8** (9): 1228–33. doi:10.1038/nn1515. PMID 16056222.
38. Moldakarimov S, Bazhenov M, Sejnowski T (2010). "Perceptual priming leads to reduction of gamma frequency oscillations". *Proc Natl Acad Sci U S A.* **107** (12): 5640–5645. doi:10.1073/pnas.0907525107. PMC 2851786. PMID 20212165.
39. Demb, J.B.; Desmond, J.E.; Gabrieli, J.D.E.; Vaidya, CJ; Glover, GH; Gabrieli, JD (1995). "Semantic encoding and retrieval in the left inferior prefrontal cortex: a functional MRI study of task difficulty and process specificity". *J. Neurosci.* **15** (9): 5870–5878. PMID 7666172.
40. Gabrieli, J.D.E.; Poldrack, R.A.; Desmond, J.E. (1998). "The role of left prefrontal cortex in language and memory". *PNAS*. **95** (3): 906–913. doi:10.1073/pnas.95.3.906. PMC 33815. PMID 9448258.
41. Dehaene, S; Naccache, L; Le Clec'h, G; Koechlin, E; Mueller, M; Dehaene-Lambertz, G; Van De Moortele, PF; Le Bihan, D (1998). "Imaging unconscious semantic priming" (PDF). *Nature*. **395** (6702): 597–600. doi:10.1038/26967. PMID 9783584.
42. Bargh, John A.; Chen, Mark; Burrows, Laura (1996). "Automaticity of Social Behavior: Direct Effects of Trait Construct and Stereotype Activation on Action". *Journal of Personality and Social Psychology*. **71** (2): 230–44. doi:10.1037/0022-3514.71.2.230. PMID 8765481.
43. (see Ironic process theory for a more in-depth discussion of this phenomenon)
44. Bargh, J.A.; Williams, E.L. (2006). "The Automaticity of Social Life". *Current Directions in Psychological Science*. **15** (1): 1–4. doi:10.1111/j.0963-7214.2006.00395.x.
45. Williams, Lawrence; Bargh, John (2008). "Experiencing physical warmth promotes psychological warmth". *Science*. **322**: 606–607. doi:10.1126/science.1162548.
46. Cox, William T. L.; Abramson, Lyn Y.; Devine, Patricia G.; Hollon, Steven D. (2012). "Stereotypes, Prejudice, and Depression: The Integrated Perspective". *Perspectives on Psychological Science*. **7** (5): 427–449. doi:10.1177/1745691612455204.
47. B. Bower. (2012). The hot and cold of priming: Psychologists are divided on whether unnoticed cues can influence behavior. *Science News*, **181**, The Hot and Cold of Priming (http://www.sciencenews.org/view/feature/id/340408 /description/The_Hot_and_Cold_of_Priming)
48. Doyen, S.; Klein, O.; Pichon, C. L.; Cleeremans, A. (2012). "Behavioral priming: it's all in the mind, but whose mind?". *PLOS ONE*. **7**: e29081. doi:10.1371/journal.pone.0029081.
49. Pashler, H.; Coburn, N.; Harris, C. R. (2012). "Priming of social distance? Failure to replicate effects on social and food judgments". *PLOS ONE*. **7**: e42510. doi:10.1371/journal.pone.0042510.
50. PsychFileDrawer, (2013). Replicability of Social and goal priming findings (http://psychfiledrawer.org/topics /view.php?t=replicability-of-social-and-goal-priming-findings-3-849).
51. Yong, Ed. "Replication studies: Bad copy". *Nature*. Retrieved 12 October 2012.
52. Kahneman, Daniel. "A proposal to deal with questions about priming effects" (PDF). Nature. Retrieved 12 October 2012.
53. Bower, Bruce. "The Hot and Cold of Priming". *Science News*. Retrieved 12 October 2012.
54. Yong, Ed. "A failed replication draws a scathing personal attack from a psychology professor". Discover Magazine. Retrieved 12 October 2012.

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