Why People Don't Swarm: Evidence for a Dual-process Memory Model in Collaborative Tagging

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ABSTRACT
We propose a dual-process memory model for incorporation into current generative models of collaborative tagging. This would be in line with a large body of research in cognitive psychology showing dissociation of implicit and explicit memory processes. We present initial findings from experimental studies that show the reality of the two memory processes in collaborative tagging. Our proposal has both theoretical and practical implications, mainly in terms of gaining a better understanding of the underlying processes in tagging and the differential impact that different manipulations in tagging environments will have on memory processes.

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Collaborative Tagging, Implicit and Explicit Memory, Process-dissociation Procedure

1. INTRODUCTION
It has become customary to regard human behavior in the use of social software systems as a form of swarming behavior. It seems to be appealing to regard human action as simple imitating behavior that only in combination with the behavior of others leads to some form of intelligence. We think this disregards a long history of research into human information processing.

Instead, we suggest that human behavior in the use of social software is driven by a sophisticated internal knowledge representation highly adaptive to the current task, and flexibly used by means of metacognitive processes. In this paper, we take collaborative tagging as a case in point and demonstrate how the internal processes can be examined with a process dissociation procedure. We show initial results that provide evidence for a dual process account of encoding and retrieval from memory.

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2. HUMAN MEMORY IN COLLABORATIVE TAGGING
When people use a collaborative tagging environment, individual memory processes are likely to play a major role. In the simplest case, one could differentiate these processes into encoding and retrieval. When a user browses a collection or searches, she observes the tags assigned to resources or displayed as tag clouds and, hence, encodes the terms in individual memory. When, on the other hand, she tags a resource herself, retrieval from memory needs to take place that allows her to assign appropriate tags.

In recent attempts to understand tagging behaviors, several generative models of tagging have been suggested that allow for simulating a user's behavior during tagging. The purpose of these models is to gain a better understanding of the emergent processes that are assumed to play a major role in these types of environments. These models – implicitly or explicitly – make assumptions on memory processes during encoding and retrieval.

Our reading of the literature suggests that two alternative conceptions have been proposed to account for these processes. Either it is assumed that a simple form of imitation takes place where tags previously used by others are used as tags for the current resource. Terms are then drawn in a random process from existing terms, and this process is influenced – among others – by the frequency and recency of use [4], [8]. Alternatively, it has been suggested that cues during encoding or retrieval (e.g. the tagged resources or other tags displayed) lead to deep conceptual processing in which a conceptual semantic memory system is called to generate appropriate terms to be used as tags [5],[6].

In cognitive psychology research, it has long been suggested that two types of memory processes play a role in all types of retrieval tasks from memory (e.g. [1][12][14]). We will refer to these here as implicit and explicit memory processes. While explicit memory preserves the context from the study episode, implicit memory does not support the conscious retrieval of the study context. Retrieving from explicit memory involves an experience of conscious and deliberate recollection, while

retrieving from implicit memory is relatively automatic and effortless and is associated with an experience of familiarity or "just knowing" [10]. While explicit memory is mainly responsible for the conscious recollection in typical memory tests (e.g. recognition or recall tests of studied material), implicit memory facilitates performance on certain tasks (e.g. identification of words or indicating preference for a stimulus) without conscious intention of recalling the study episode.

Support for the empirical reality of this distinction has been obtained through numerous experimental studies in which dissociation of performance attributed to these two memory processes could be observed. This means that both processes contribute independently to a certain memory performance, and that the systems can be influenced independently by different manipulations, both during encoding or retrieval (e.g. [15][16]). For example, semantic elaboration during encoding (e.g. conceptually elaborating on an item when studying it) has a large positive effect on explicit memory (e.g. consciously recalling the item), which is consistently larger than on implicit memory (e.g completing a word stem [7]). On the other hand, several manipulations of processing fluency during retrieval (e.g. how easy it is to read an item) have effects on implicit memory and no effect on explicit memory (e.g. [3]).

3. EXAMINING DISSOCIATIONS: A METHOD AND INITIAL RESULTS

Because implicit and explicit processing can not simply be observed from behavioral data or from tag data in a tagging environment, it is necessary to carefully design experimental studies in which the two types of processes can be studied, and devise sophisticated models that allow estimation of parameters for these internal processes.

In our own research, we look at how users process tags they observe in a collaborative tagging environment. For example, we have tried to discern explicit and implicit memory processes with an adapted *process dissociation procedure* initially suggested by Jacoby (1991) [9]. In this procedure, users first process tags in an incidental processing conditions: they have to make decisions on which content is more suitable by looking at tags assigned to that content. In a second phase, they are then asked to intentionally learn a number of tags from the same environment. When they are tested for their memory of the tags in a later memory test, one group is asked to name all tags (incidentally learned or intentionally learned) while another group is asked to produce only those tags that were intentionally learned.

A *multinomial model* [2] can then be used to obtain independent estimates of probabilities for two memory processes during retrieval, an explicit recollection (explicit) and a familiarity-based judgment process (implicit).

Our initial findings firstly suggest that a dual process model that involves independent retrieval processes from explicit and implicit memory is suitable to explain performance in the memory test after the search task. This is shown by significance of the overall model and means that both processes contribute to memory performance. Secondly, across several search task conditions, we find that processes of explicit recollection are more important for performance than implicit processes. This is indicated by a significant difference in the two parameters. Finally, we have found evidence that the two memory processes can be selectively manipulated. To show this, we have instructed users to search with different intentions (e.g. looking for material for a private leisure activity vs. looking for material for a homework assignment). Initial results indicate that estimates for the memory processes do in fact vary with search intention. This is in line with research showing that metacognitive strategies can influence implicit and explicit memory processes [13].

4. CONCLUSIONS AND IMPLICATIONS

In concluding from the above, a dual process model as we are suggesting should help us gain a better theoretical understanding of collaborative tagging processes and the underlying cognitive mechanisms. We see mainly two areas where such enhancements would be beneficial. First, current generative models that look at microprocesses in collaborative tagging would benefit from incorporating a two-stage memory process as we are suggesting. A formal approach as suggested above would lend itself for inclusion into generative models of tagging. Familiarity-based retrieval is usually conceptualized as decision process involving a continuous variable with a varying response criterion (strict or lenient), much the same as in a signal detection model of memory. Explicit recollection, on the other hand, is characterized as a discrete memory process that involves distinct states and transitions of learning or forgetting [16] which could be captured through a markov model.

Secondly, we assume that our dual process memory model might shed new light on a recent attempt to explain tagging motivations. Körner et al. [11] have proposed a typology of user motivations, classifying users as describers or categorizers. This assertion is mainly based on the observation of empirical tagging behavior, whereas the theoretical underpinning of this model is limited. We suspect that the two tagging patterns observed by Körner et al. could be mapped to the two memory processes we are suggesting, where the "describer pattern" would be driven mainly by implicit memory processes, and the "categorizer pattern" mainly by explicit ones.

Furthermore, our research has practical significance as well. A dual process memory model for collaborative tagging would suggest that different manipulations made in the tagging environment will impact the two memory processes in different ways, and hence have a differential impact on the generation of tags in these environments. As a result, concrete hypotheses could be proposed. As to manipulations during encoding, one would expect that generating tags vs. simply reading through tags should impact explicit memory processes more than implicit ones. The same is to be expected for other manipulations that target deep semantic processing during encoding (e.g. displaying tags as a network of semantically related tags). During retrieval, on the other hand, we would expect that tag recommendations given at retrieval time would influence implicit memory processes more than explicit memory processes. Also readability of these recommendations (e.g. varying font size as is common in tag clouds) should influence processing fluency and therefore impact implicit memory processes more than explicit ones. Moreover, different forgetting curves have been obtained for explicit as compared to implicit memory representations [16].

We have only listed some of the more obvious hypotheses above. We would argue that an integrated dual process model of memory could make predictions about a large number of memory phenomena during tagging, and – given the right experimental paradigms – these could be systematically studied.

5. REFERENCES

[1] Brainerd, C.J., Wright, R., & Reyna, V.F. 2002. Dual-Retrieval Processes in Free and Associative Recall. *Journal of Memory and Language, 46*, 120-152.

[2] Buchner, A., Erdfelder, E., and Vaterrodt-Plünnecke, B. 1995. Toward Unbiased Measurement of Conscious and Unconscious Memory Processes Within the Process Dissociation Framework. *Journal of Experimental Psychology: General, 124*, 137-160.

[3] Cameron, T.E., & Hockley, W.E. 2000. The revelation effect for item and associative recognition: Familiarity versus recollection. *Memory & Cognition, 28*, 176-183.

[4] Cattuto, C., Loreto, V., & Pietronero 2007. Semiotic dynamics and collaborative tagging. *PNAS, 104*, 1461-1464.

[5] Fu, W. 2008. The microstructures of social tagging: a rational model. *Proceedings from CSCW'08*, pp. 229-238. New York: ACM Press.

[6] Fu, W., Kannampallil, T.G., Kang, R. 2009. A semantic imitation model of social tag choices. *Proceedings of the International Conference on Computational Science and Engineering CSE '09*, pp. 66-73, IEEE Computer Society.

[7] Gardiner, J.M. 1988. Functional aspects of recollective experince. *Memory & Cognition, 16*, 309-313.

[8] Halpin, H., Robu, V., & Shepherd, H. 2007. The complex dynamics of collaborative tagging. *Proceedings from WWW'07*, pp. 211-220. New York: ACM Press.

[9] Jacoby, L.L. 1991. A process dissociation framework: Seperating automatic from intentional uses of memory. *Journal of Memory & Language, 30*, 513-541.

[10] Kelley, C.M., & Jacoby, L.L. 2000. Recollection and Familiarity: Process-Dissociation. In E. Tulving & F. Craik Eds. *The Oxford handbook of memory*, pp. 215-228. Oxford: Oxford University Press.

[11] Körner, C.; Benz, D.; Strohmaier, M.; Hotho, A. & Stumme, G. 2010. Stop Thinking, start Tagging - Tag Semantics emerge from Collaborative Verbosity, in *Proceedings of the 19th International World Wide Web Conference WWW 2010*, ACM Press, Raleigh, NC, USA .

[12] Mandler, G. 1980. Recognizing: The judgement of previous occurrence. *Psychological Review, 87*, 252-271.

[13] Narens, L., Graf, A. and Nelson, T. O. 1996. Metacognitive Aspects of Implicit/Explicit Memory, In *Implicit memory and metacognition*, Lynne Reder, Ed., Routledge, pp. 137-170

[14] Nelson, D.L., Fisher, S.L., & Akirmak, U. 2007. How implicitly activated and explicitly acquired knowledge contribute to the effectiveness of retrieval cues. *Memory & Cognition, 35*, 1892-1904.

[15] Nelson, D.L., McKinney, V.M., Gee, N.R., & Janczura, G.A. 1998. Interpreting the Influence of Implicitly Activated Memories on Recall and Recognition. *Psychological Review, 105*, 299-324.

[16] Yonelinas, A.P. 2002. The Nature of Recollection and Familiarity: A Review of 30 Years of Research. *Journal of Memory and Language, 46*, 441-517.