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DEVELOPMENT OF THE WEB TOOL “DYNAMIC UX GRAPH” FOR EVALUATING THE UX

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ABSTRACT

The UX graph, an evaluation method of the UX, was originally developed as a paper-based tool to record the degree of satisfaction on a time scale since the start of use of a product. We developed a Web-based tool for recording and analyzing a UX graph where it is possible to exchange the experience episodes, and to change the value of satisfaction as an easy-to-use evaluation method of UX. The tool dynamically shows the UX graph by allowing users to manipulate the experience episode and the graph curve by finger or mouse. In addition to the development, its usability was tested using the β version.

Keywords: UX, user experience, human-centered design, evaluation, satisfaction.

I. INTRODUCTION

The idea of human-centered design, which was filed in 1999 according to the standards of ISO13407, does not focus on technological development, but is an approach to manufacture centered on the needs of the user [1]. When ISO13407 is revised to ISO9241-210, the development of artifacts that aim to improve the various experiences and quality of life of users was recommended, with “achievement of a high quality user experience (UX: User experience)” being the aim of human-centered design [2]. In recent years, there has been a growing approach to analyze UX evaluations related to the artifacts by directly grasping the subjective impressions and feelings of the user based on the UX.

In this research, we have developed a Web-based tool (hereinafter, UX graph tool) based on a UX graph which, even among the evaluation method of UX, makes it easier for those telling their experiences to express them, and for those analyzing their experiences to intuitively understand the experiences.

The following problems arose in the UX graphs created in the original paper, despite having been given proper instruction.

- (a). As it is hand-written on paper, the co-ordinate points and text (experience episodes), once written, can be difficult to correct, and even when corrections are necessary, they may not be made at times due to it being troublesome.
- (b). If writing is untidy for the same reason, the characters in text can be difficult to read.
- (c). Some people tend to mix-up the positions of the default horizontal axis co-ordinates (prior expectations, the start of use, current, prediction) and the additional text from the start of use to current, and forget to label the horizontal axis co-ordinates.
- (d). Even though a text entry area has been provided in the form for creating the UX graphs, some people tend to write the text inside the graph area.

By providing an interactive user interface to solve these kinds of problems, the UX graph tool assist with the creation of UX graphs by informants that co-operate with UX evaluations. While it is desirable to combine individual interviews to improve the reliability of data from UX evaluations, it is difficult to handle a lot of data. Investigations and research continue in search of a method that will not impair data reliability, even when applied to group methods to collect and analyze a greater amount of UX evaluation data.

This paper reports on the summary of the UX graph tool and the results of its user evaluations.

II. METHOD OF UX EVALUATIONS AND ADVANTAGE OF UX GRAPHS

2.1 UX and its evaluation

While UX is defined as “The perception and reaction of people that arises when using products, systems, and services” in ISO9241-210, evaluations of UX must take into consideration the relationship between the quality of artifacts, their uses, and the satisfaction of users.

Hassenzahl[3] classified the user experiences into pragmatic quality and hedonic quality, and presented this theoretical model, saying that both of these qualities will affect the actions and satisfactions of use. For these pragmatic and hedonic qualities, the former is equivalent to objective product quality such as functions and performance of artifacts, as well as usability, while the latter is equivalent to subjective product quality in the form of satisfaction, excitement, and fun from using the product; both these qualities are thought to affect the UX evaluations.

In the UX White Paper [4], there are four types of UX; those that are anticipated UX, momentary UX, episodic UX and cumulative UX (Figure 1). As indicated in the UX white paper, UX includes experiences over a long-term period from before, during, and after the use of artifacts, and as its evaluations include individual evaluations for each period as well as the overall evaluations. The UX can be distinguished by each phase of usage in the whole usage cycle with artifacts. Because the UX evaluations contain individual evaluations as well as the overall evaluations, the ability to carry out the long-term evaluations is necessary.

In practice, medium- and long-term UX tends to experience changes in the quality of its evaluations. For example, where initial emphasis is on novelty, emphasis may switch towards ease-of-use, and where the learning process at first can be stressful, the errors in usability may recover and become less bothersome with familiarity and proficiency over time. Therefore, it can be said that UX is not intended for evaluations at a particular value, but should instead be evaluated by grasping the dynamic changes.

The purpose of UX evaluations is to evaluate based on these objective experiences felt by the user, and to grasp changes in these experiences, so short-term UX evaluations are considered insufficient.

2.2 Method of UX evaluations and the UX graphs

The methods used to evaluate UX include a real-time method and a method of carrying out evaluations retrospectively. The former includes the use of the Experience Sampling Method (ESM [5-6]), which, despite allowing for real-time evaluations, has problems such as limitations to the situations where it can be used, and difficulty in making long-term evaluations. Retrospective methods include the AttrakDiff [7] which evaluates the pragmatic and hedonic qualities using a rating scale, as well as the Day Reconstruction Method (DRM [8]), CORPUS [9], iScale [10], UX curve [11] and UX graph [12].

Of these, the UX graph and its predecessor, the UX curve, were the two methods developed for the purpose of UX

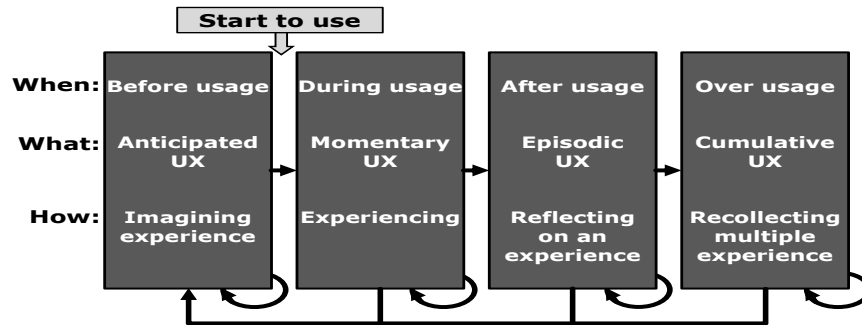


Figure 1: Four types of UX in the UX white paper (2011)

evaluations. UX graphs primarily show improvement in the following points in comparison to the UX curves method.

- (a). With emphasis on the episodes, the curve was to be drawn later as a means to link everything together.
- (b). Expectations before use and future predictions were added as episodes.
- (c). As attractiveness is close to satisfaction in the UX curves, satisfaction was used as an indicator for evaluation.

2.3 Advantages of the UX Graphs

The following points are the main advantages of using UX graphs for UX evaluations.

- (a). Where target products and services are used, the UX evaluation is a certain value; this value differs at other time points, allowing one to see the fluctuations in the evaluations depending on the time of evaluations (of most recent episodes) and providing a dynamic grasp of the UX.
- (b). Factors that change the evaluations can be understood from the fluctuations in the graphs and their corresponding episodes, and in developing the artifacts, parts to reinforce (episodes that lead to positive evaluations) and parts to improve (episodes that lead to negative evaluations) can be considered to improve the UX evaluations.

III. OVERVIEW OF THE UX GRAPH TOOL

Although the original UX graph was a paper-based method, we developed a web based tool. The β -version of UX graph tool is open to public free of charge (on <https://ux-graph.com/>) from December 2015, and it can be used by anybody, under the environment of use described later.

Renovation of functional and user interfaces are currently underway. The content in this paper that concerns the UX graph tool has been written with regards to the latest β Ver. 0.4, as of May 25th, 2016, and the graph tool may be renovated by the time this paper has been read. The latest English and Japanese versions are available at the following websites:

<https://ux-graph.com/ver4/index.php?lang=en>

<https://ux-graph.com/ver3/>

3.1 Environment of Use

The UX graph tool can be used by anybody, on PC or tablets, and smartphones with internet systems that satisfies the following points.

- (a). The device is equipped with system that allows for saving / browsing of PDF files.
- (b). The device is equipped with system that allows for use of modern browsers such as the latest version of Firefox or Chrome.

3.2 How to Use the UX Graph Tool

The following describes the method of use for the UX graph tool.

(1) Inputting Demographic Information and Targeted Usage

The “age” and “sex” of the Informant is selected, and the artifact targeted for evaluation is entered into the “targeted usage” section (Figure 2).

(2) Episode Entry

Figures 3-7 show the entry screen for the episodes (event). The following five types of episode entries are made:

- prior experience (while imagining the expectations before acquiring the targeted artifact) (Figure 3),

The screenshot shows a form titled "Age and Sex of informant". It contains two dropdown menus: "Age" and "Sex". The "Sex" dropdown is open, showing "male" and "female" as options. Below these are two more dropdown menus: "Targeted Use" and "Relationship".

Figure 2: Data entry screen of age/sex and the experience

The screenshot shows a form titled "#Experience Prior". It contains a date selection field labeled "Date of Experience (Estimation)" with two dropdown menus for day and month. Below this is a text input field labeled "Content Experience" with the example text "(example: I saw other people using it and wanted it too.)". At the bottom is a dropdown menu labeled "Expectation/Satisfaction Scale (-10 to +10)" with the value "0" selected.

Figure 3: Entry screen of experience prior

The screenshot shows a form titled "#Time of start of use". It contains a date selection field labeled "Date of Experience (Estimation)" with two dropdown menus for day and month. Below this is a text input field labeled "Content Experience" with the example text "(example: I wanted this the whole time. I'm very happy to get it!)". At the bottom is a dropdown menu labeled "Satisfaction Scale (-10 to +10)" with the value "0" selected.

Figure 4:Entry screen of initial experience



Figure 5: Card type entry screen of episodes

- initial experience (impressions at the time of start of use) (Figure 4),
- experience episodes up to now (Figure 5),
- current feelings (current evaluation) (Figure 6),
- future expectations (predictions beyond the current state) (Figure 7).



Figure 6:Entry screen of current feelings



Figure 7: Entry screen of future expectations



Figure 8: Screen image while exchanging episodes

Episodes consist of “date of experience,” “content experience” and “satisfaction scale (-10 to +10).” The date of experience is preferred, but is not mandatory. Satisfaction levels can be changed from -10 to +10, using the satisfaction scale bar on each episode card, which can also be changed on the graph later. Episodes on prior experience, initial experience, current feelings, and future expectations were regarded as fixed episodes (Figures 3-4, 5-6), with their “content experience” all being regarded as essential. The number of episodes from the start of use to current can be switched by dragging and dropping them for changing timeline even after creating the episodes, as shown in Figure 8.

After inserting all necessary information in the columns, the graph will be displayed.

(3) Arrangement the UX Graph Charts

The axes on the UX graph charts were set to be timed on the horizontal axis (past towards the left, future towards the right) and the satisfaction levels on the vertical axis (above the origin being positive, and below the origin being negative), same as with the UX graphs [11-12]. To arrange the graph, each episode point is dragged up and down to control each satisfaction scale bar or manually adjust the graph.

The content of experience appears when hovering the mouse cursor over the episode point and it was made possible to edit the content of experience by clicking this display (Figure 9). Furthermore, the order of the “episodes” from the start of use to current, which are not fixed episodes (the experience prior, initial experience, current feelings and future expectations), can be switched around by dragging the vertical axis of each episode between the left and right to create correct timeline on the graph. Whenever the “Satisfaction” levels are controlled, or the episode orders are switched around, the UX graph chart is re-drawn, so as to connect the points.

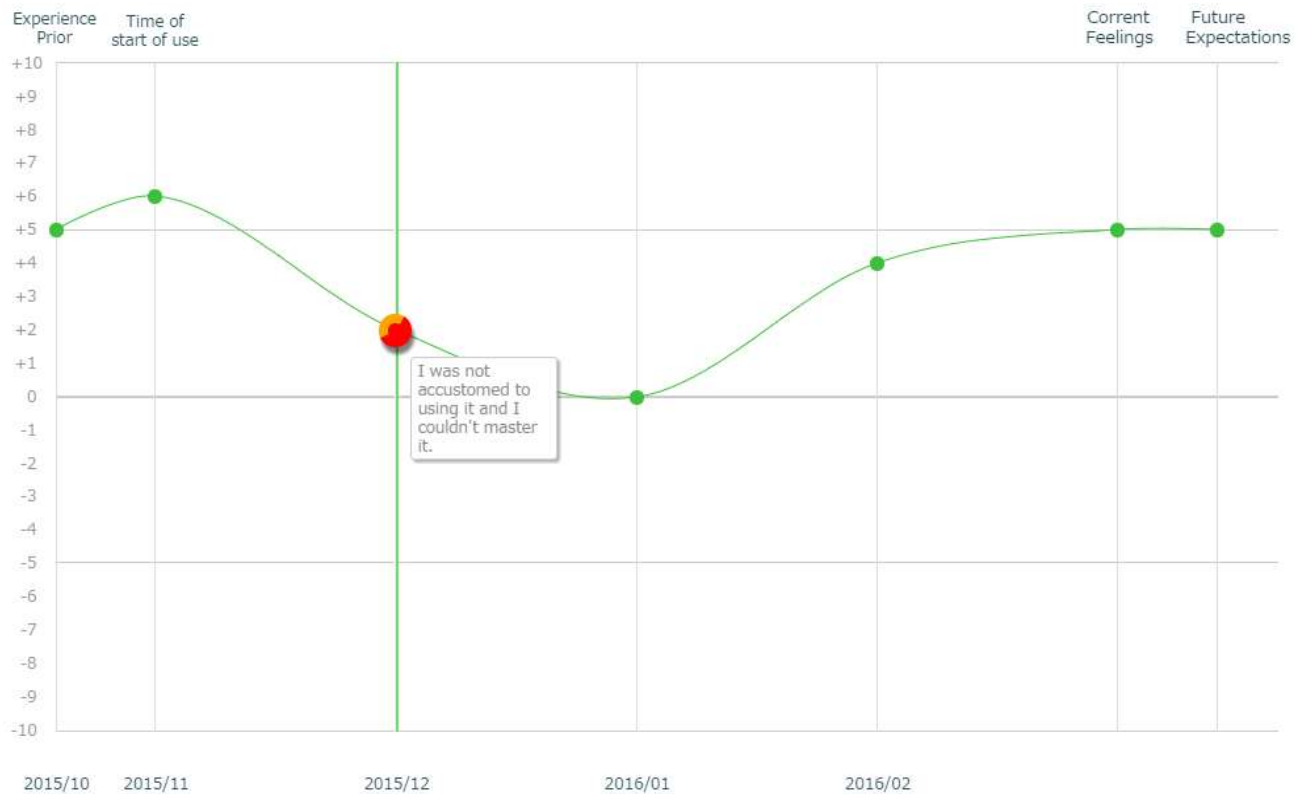


Figure 9: The created UX graph chart with the experience at the episode point

(4) Downloading the UX Graph Data

Finally, by pressing the “download as PDF” button below the UX graph data, the UX graph data can be downloaded as a PDF to be displayed and saved.

3.3 The UX Graph Tool’s Benefits

The following points are the main advantages of using the UX graphs tool for UX evaluations.

- The value differs at other time points, allowing one to see the fluctuations in the evaluations depending on the time of evaluation and providing a grasp of the dynamic UX.
- In the development of the artifacts, parts to be reinforced and parts to be improved can be shown to analyze the UX evaluations.
- Compared to the original paper-based method, this interactive tool facilitates users to change the coordinate of the experience episode point/ vertically and horizontally.

IV. USER EVALUATION OF UX TOOL

A user evaluation to grasp the merits and points for improvement of UX graph tool, interview was held after requesting subjects to use the UX graphs.

4.1 Method

User evaluations were conducted by asking 13 employees (12 males, 1 female) from a company affiliated with the first author to use the UX graph tool. The average age of the collaborators was 32.2 years old (SD = 4.1). Interview was held after the subjects were asked to create UX graphs using the UX graph tool, concerning the two themes: “experience at the current company (hereinafter, “theme A”) and “experiences with smartphones (hereinafter, “theme B”).

4.2 Results

(1) Time Required

Table 1 shows the time required to create UX graphs using the UX graph tool, for each of theme A and theme B. The average time taken was approximately 20 minutes. Time taken has been shortened compared to the approximately 30 minutes or more taken with the paper-based version.

(2) Number of Episodes

Table 2 summarizes the number of entries for episodes other than the fixed episodes (prior expectations, start of use, current and future predictions). The average was around seven, which did not show a significant difference from the paper-based version.

(3) Starting Time

Table 3 shows the time at which experiences for each theme started. While the entries are optional for the time period of each episode, the number of valid responses for the starting time of the experience numbered 11 for theme A and 9 for theme B. Of these, the number of responses that provided entries for both year and month was 11 for theme A, and only 4 for theme B.

(4) Comments for the UX Graph Tool

Of the opinions that were raised, comments concerning usability, time, satisfaction, and the episodes were compiled.

a. Comments concerning Usability

- Ability to intuitively control charts with a mouse that are otherwise difficult to express on paper.
- Episodes can be easily switched around using mouse controls.
- Revisions can be made easily, and are not so stressful.
- Interesting / fun to be able to move the contents around.

b. Comments concerning Time

- Time period is ambiguous, and it takes time to recall.
- Time period is ambiguous, but process can be recalled.
- Time axis up to around two and a half years can be recalled.

- Can make entries while organizing things in the header.

c. Comments concerning Episodes

- Unsure as to how much detail the episodes need to be described in.
- Even if forgotten, I feel there are several important points.
- As details remain as visible information, you tend to review it to see if the contents are correct.

d. Comments concerning Satisfaction

- Difficult to express expectation and satisfaction in numbers.
- Expressions are difficult when you are in a complex mental state, like “half expectant, half anxious”.
- I remember the episode, but my feelings back then are ambiguous.
- I don’t understand the difference between “expectation: 0” and “expectation: negative value”.
- Rather than an abstract endpoint like satisfaction, it is easier to provide intuitive responses to criteria like “good / bad feelings”.

Table 1: Time of Using the UX Graph Tool

	Theme A	Theme B
Input Time	4-40 minutes	5-60 minutes
(Mean Value)	19.0 minutes	20.4 minutes
(Median)	15 minutes	15 minutes

Table 2: Number of Total Episodes

	Theme A	Theme B
Number of Episodes	3-16 episodes	3-19 episodes
(Mean Value)	6.9 episodes	6.5 episodes
(Median)	5 episodes	5 episodes

Table 3: Starting Time of the Theme

	Theme A	Theme B
Starting Time for the Experience (Median)	4.5 years ago	7 years ago

4.3 Discussion

Of the comments raised during the hearing, those concerning the usability of the tool itself generally reflected the development guidelines. Meanwhile, there were many comments raised about how the time period of each episode cannot be recalled accurately. This can be considered equivalent to the problem encountered in the UX curves and the UX graphs, where reliability of past episodes declines because graphs are created from memory. The fact that losses and changes occur to memory [13] and the inability to remember, in detail, all experiences over a long-term [14] are retrospective limitations to UX evaluations, and one can find meaning in these evaluations if it is considered an overall evaluation of past events up to the time when the UX graph is created. Furthermore, since the memory of experiences leads to future actions [10], and since retrospective evaluations are more effective in predicting actions than day-to-day evaluations [15], UX evaluations using the UX graph tool may be used to predict the future actions of users.

On the other hand, the inability to take a simple average, due to the length of the horizontal axis (time period) varying between people, is a problem for UX curves and UX graphs [1]. The UX graph tool, too, does not allow for simple aggregation of entries of figures of satisfaction. This is because satisfaction levels go through qualitative changes due to various factors including past experiences, prior predictions, and the context of episodes, etc.

During the hearing, several comments were made suggesting difficulties with entries of satisfaction levels, and there were cases seen here and there where hesitations arose when making entries about episodes and satisfaction levels, due to varied perceptions of the word “satisfaction”. This point is also a problem shared with the UX curves and the UX graphs, but this can be complemented by adding an interview. There have been ideas to add an online interview that would provide text-based responses to specified items instead of a face-to-face interview. We will take this on as a future challenge to see whether this point can be rectified using only this tool.

Although it is difficult to grasp the overall trend in relation to the two issues adopted in this user evaluation through the UX graphs that were created, and while there were 5 responses out of a total of 26 responses between both themes that had negative values for prior expectations, there were no cases presenting negative values for future predictions. When considering the standpoint of the aforementioned behavior predictions, results predicted the continued life of collaborators at the company, and the continued use of smartphones.

Furthermore, data obtained from “Experience at the current company” in Theme A represents the employees’ satisfaction itself, and the UX Graph Tools can be used to reconcile the directionality of the company and its employees. In other words, UX Graph Tools may be used not only in terms of the experiences for using a product, but also for assessing people’s daily experiences. Elsewhere, using the UX Graph Tools for management and team building exercises within a company may prove their usefulness in terms of internal management.

While user evaluations of this tool suggested that some of the problems seen in the UX graphs remain with the UX graph tool, we were also able to understand the merits of this tool in mitigating informants’ stress during data entry as well as its richness in terms of scalability. Other than the comments raised during the hearing, the fact that data can be easily saved and handled by converting the content of experience into PDF format, and the improved readability relative to hand-written data are also merits of the UX graph tool.

V. CONCLUSION

In this research, we developed a Web-based tool for UX graphs and released the β -version for widespread use to make it easier to handle data based on UX graphs.

This paper discussed an overview of the UX graph tool, and summarized the results of user evaluations conducted using the UX graph tool. Similar to the paper-based version the UX graph is still dependent on memory, and is difficult to convert the feeling into the concept of satisfaction. It can be considered the limitation of the retrospective methods with the former. On the other hand, unlike the paper-based UX graph, it will be of help to the subject to input data without lack of information for UX evaluations.

The tool can be used for supporting an interview in the user survey for comprehending user, and it also can be applied to the management of organization. Explanations and establishment of a user interface to make entries of satisfaction levels smoother remain as future challenges.

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REFERENCES

1. ISO 13407:1999, *Human-centred Design Processes for Interactive Systems*, 1999.
2. ISO 9241-210:2010, *Ergonomics of Human-System Interaction-Part 210: Human-centred Design for Interactive Systems*, 2010.
3. Marc Hassenzahl: *The Thing and I: Understanding the Relationship Between User and Product*, Funology: From Usability to Enjoyment, Kluwer, pp.31-42,2003.
4. Virpi Roto, Effie Law, Arnold Vermeeren, and Jettie Hoonhout (eds): *User Experience White Paper: Bringing clarity to the concept of user experience*, Outcome of the Dagstuhl Seminar on Demarcating User Experience, Germany, 2011.
<http://www.allaboutux.org/uxwhitepaperReed> (accessed, May 2016)
5. Reed Larson and Mihaly Csikszentmihalyi: *The Experience Sampling Method, New Directions for Methodology of Social and Behavioral Science*, Vol.15, pp.41-56, 1983.
6. Daniel Kahneman, Alan B. Krueger, David A. Schkade, Norbert Schwarz, Arthur A. Stone: *A Survey Method for Characterizing Daily Life Experience. The Day Reconstruction Method*, Science, Vol.306, pp.1776-1780, 2004.
7. Marc Hassenzahl, Michael Burmester and Franz Koller: *AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität (AttracDiff: A Questionnaire to Measure Perceived Hedonic and Pragmatic Quality)*” Mensch COMPUTER 2003 Interaktion in Bewegung, pp. 187–196, 2003.
8. Evangelos Karapanos, John Zimmerman, Jodi Forlizzi and Jean-Bernard Martens: *User Experience Over Time: An Initial Framework*, ACM SIGCHI 2009 Proceedings, pp.729-738, 2009.
9. Von Wiliamowitz-Moellendorff, Marc Hassenzahl and Axel Platz: *Dynamics of User Experience: How the Perceived Quality of Mobile Phones Changes Over Time*, "User Experience - Towards a Unified View" The 2nd COST294-MAUSE International Open Workshop at the 4th Nordic Conference on Human-Computer Interaction, pp.74-78, 2006.
10. Evangelos Karapanos, John Zimmerman, Jodi Forlizzi and Jean-Bernard Martens: *Measuring the Dynamics of Remembered Experience Over Time*, Interacting with Computers, Vol.22, No.5, pp.328-335, 2010.
11. Sari Kujala, Virpi Roto, Kaisa Vaananen-Vainio Mattila, and Arto Sinnela | Kujala,: *UX Curve: A Method for Evaluating Long-Term User Experience*, Interacting with Computers, 2011.
12. Masaaki Kurosu: *Is the evaluation of satisfaction by the UX graph based on the accumulation or the recency?*, JSKE Proceedings 2015 Spring, 2015.
13. Michael Ross: *Relation of Implicit Theories to the Construction of Personal Histories*, Psychological Review, Vol.96, No.2, pp.341-357, 1989.
14. Donald Arthur Norman: *Memory is More Important than Actuality*, Interactions, March+April, pp.24-26, 2009.

15. *Shigehiro Oishi and Helen W. Sullivan: The Predictive Value of Daily vs. Retrospective Well-being Judgments in Relationship Stability, Journal of Experimental Social Psychology, Vol.43, pp.460-470, 2006.*