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(54) **Title**: METHOD AND SYSTEM FOR DETERMINING MEMORABILITY OF AUDIO AND/OR VISUAL CONTENT

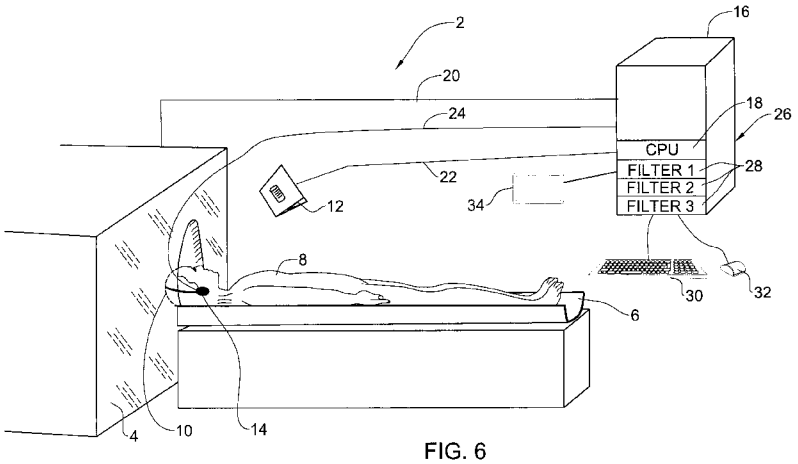

FIG. 6

(57) **Abstract**: System (2) and method for determining memorability of one or more audio and/or visual content items. In the system, one or more presentation devices (12,14) are used to present the audio and/or visual content items to one or more individuals. A monitoring apparatus monitors (4) a level of neural stimulation in one or both of the precuneus and the superior temporal sulcus (STS) of an individual during exposure of the individual to the audio and/or visual content items, and generates data indicative of the level of stimulation of one or both of the precuneus and the STS in the individual. A CPU (16,18) processes the data generated by the monitoring apparatus from one or more individuals to calculate one or more memorability scores of each of the one or more content items presented to the individual.

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METHOD AND SYSTEM FOR DETERMINING MEMORABILITY OF AUDIO AND/OR VISUAL CONTENT

FIELD OF THE INVENTION

This invention relates to methods and systems for assessing the effects of audio and/or visual content.

BACKGROUND OF THE INVENTION

The following prior art publications are considered to be relevant for an understanding of the background of the invention:

Aaker, Jennifer L. (1997), "Dimensions of Brand Personality," Journal of Marketing

Allison, Truett, Aina Puce, and Gregory McCarthy (2000), "Social Perception from Visual Cues: Role of the STS Region," Trends in Cognitive Sciences, 1 (July), 267–78.

Canli, Turhan, Zuo Zhao, James Brewer, John Gabrieli, and Larry Cahill (2000), "Event-Related Activation in the Human Amygdala Associates with Later Memory for Individual Emotional Experience," Journal of Neuroscience, 20 (October), RC99.

Hamann, Stephan (2001), "Cognitive and Neural Mechanisms of Emotional Memory," Trends in Cognitive Science, (September), 394–400.

Ioannides, Andreas A., Lichan Liu, Dionyssios Theofilou, Jürgen Dammers, Tom Burne, Tim Ambler, and Steven Rose (2000), "Real Time Processing of Affective and Cognitive Stimuli in the Human Brain Extracted from MEG Signals," Brain Topography, 13 (September), 11–19.

Kenning, Peter, Hilke Plassmann, H. Kugel, W. Schwindt, A. Pieper, Michael Deppe (2007), "Neural Correlates of Attractive Ads, FOCUS-Jahrbuch 2007, Schwerpunkt: Neuroeconomy, Neuromarketing, Neuromarktforschung, Wolfgang. J. Koschnick, ed., FOCUS Magazin Verlag: Munich; 287–98.

eds., New York: Guilford Press, 601–17.

Kriegstein, Katharina V., and Anne- Lise Giraud (2004), "Distinct Functional Substrates Along the Right Superior Temporal Sulcus for the Processing of Voices," NeuroImage, 22 (June), 948–55.

US Patent No. 6,099,319 to Zaltman

US Patent Publication No. 2009030303

Consumers are exposed to a considerable number of advertisements on a daily basis. Often there is a significant time delay between exposure to an ad and the decision making of consumers concerning the product. Thus, in order for an ad to be effective, it is crucial that it be memorable. Recognizing the importance of ad memorability, many researchers have attempted to determine factors that enhance memory of an ad. One such factor is affective response following exposure to an ad.

One difficulty in the study of the process by which affect influences memory relates to the measures that are indicative of the underlying process. Thus far, researchers have used a variety of measures to assess emotional reactions, including verbal self-report, visual self-report, moment-to-moment ratings, and autonomic measures. These measures, however, are usually limited in their ability to provide insights regarding the mechanism by which affect influences memory.

Functional neuroimaging and other methods have indicated that emotional stimuli engage specific neural mechanisms that enhance memory. Studies have pointed to the key role of the amygdala, an almond-shaped region of the medial temporal lobe, in enhancing memory for emotional stimuli (Hamann 2001). Research has shown a high degree of correlation between amygdala activation during encoding and subsequent memory for emotional experiences (Canli et al. 2000) and that the memory-enhancing effects of emotional arousal involve interactions between sub-cortical and cortical structures coordinated by the amygdala.

Ioannides et al. (2000) employed MEG (Magnetoencephalography) brain imaging in order to observe the differences in brain activation during exposure to affective and cognitive advertising stimuli. Their results revealed significant differences in brain activation between affective and cognitive advertising segments. Their data suggest that cognitive advertisements produce stronger activity in the posterior parietal areas and the superior prefrontal cortex than affective ads. In addition, they found that

affective advertisements modulated activity in the orbitofrontal and retrosplenial cortices, the amygdala, and the brainstem.

When neural cells are active they increase their consumption of energy from glucose and switch to less energetically effective, but more rapid anaerobic glycolysis. The local response to this energy utilization is to increase blood flow to regions of increased neural activity. This leads to local changes in the relative concentration of oxyhemoglobin and deoxyhemoglobin and changes in local cerebral blood volume and in local cerebral blood flow. Functional magnetic imaging (fMRI) measures this hemodynamic response (the change in blood flow) related to neural activity in the brain or spinal cord using blood oxygenation level dependent (BOLD) contrast. A study by Kenning et al. (2007) using fMRI to monitor neural activity, indicated that the attractiveness of 30 pre-selected and classified print advertisements was correlated with changes in brain activity in the nucleus accumbens, the posterior cingulate, the medial prefrontal cortex, higher-order visual cortices, and the fusiform face area.

US Patent No. 6,099,319 to Zaltman discloses exposing a subject to advertising. Brain responses to the advertising are measured from neuroimaging data. The results of the measurements are used to predict future behavior of the subject with respect to purchase or consumption of products.

US Patent Publication No. 2009030303 discloses use of neuro-response data to evaluate the effectiveness of stimulus materials such as marketing and entertainment materials. A data collection mechanism, including multiple modalities such as, electroencephalography (EEG), functional magnetic resonance imaging (fMRI), electrooculography (EOG), galvanic skin response (GSR), collects response data from subjects exposed to marketing and entertainment stimuli.

SUMMARY OF THE INVENTION

The present invention is based on the novel and unexpected observation that exposure to memorable audio and/or visual content causes neural stimulation of the STS and the precuneus. As shown below, individuals, when exposed to marketing communication (messages and related media used to communicate with a market) previously determined to be memorable, showed stimulation of the STS, and the precuneus, which was significantly greater than when exposed to ads that were

previously determined to be unmemorable. The STS is a cortical structure for social cognition that governs social perception in two main domains: auditory social perception (Kriegstein and Giraud 2004) and more complex social perception, including analysis and interpretation of others (Allison, Puce, and McCarthy 2000). The precuneus is a part of the superior parietal lobule hidden in the medial longitudinal fissure between the two cerebral hemispheres. It is sometimes described as the medial area of the superior parietal cortex.

Thus, in one of its aspects, the present invention provides a method for determining an extent of memorability of audio and/or visual content, such as marketing communication. In accordance with this aspect of the invention, one or more individuals are exposed to the audio and/or visual content, and an extent of stimulation of one or both of the precuneus, and the STS is scored.

The scoring may be binary. In this case, if the extent of stimulation is below a first predetermined threshold, a score of "0" is assigned, indicating that the content is unmemorable. If the extent of stimulation is above a second predetermined threshold, a score of "1" is assigned, indicating that the content is memorable. Alternatively, a continuous scoring may be used, for example, from 0 to 1, indicative of the extent of memorability.

For example, each of one or more individuals may be presented with one or more content items, and an extent of stimulation is determined for each pair of an individual and content item. One or both of the following scoring methods could then be used:

(1) For each content item, an average and standard deviation of the determined extents of stimulation by each individual can be calculated. Content items eliciting a level of stimulation below a predetermined number of standard deviations below the average could assigned a score of "0" (unmemorable content item), while those content items eliciting a level of stimulation above a predetermined number of standard deviations above the average could be assigned a score of "1" (memorable content item).

(2) For each individual, an average and standard deviation of the determined extents of stimulation by each content element can be calculated.

In both cases, content items eliciting a level of stimulation below a predetermined number of standard deviations below the average could assigned a score of "0" (unmemorable content item), while those content items eliciting a level of stimulation above a predetermined number of standard deviations above the average could be assigned a score of "1" (memorable content item). Alternatively, a continuous scoring could be used in which each content item is assigned a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited.

In one embodiment, functional magnetic imaging (fMRI) is used to obtain images of one or both of the precuneus and the STS providing indications of the level of neural stimulation in the brain. The fMRI images can then be analyzed and the extent of neural stimulation in the precuneus and/or the STS can be scored. In other embodiments, brain imaging by other techniques, such as positron emission tomography, magnetoencephalography and single photon emission computer tomography, may be used to monitor neural activity in the precuneus and STS.

In another of its aspects, the invention provides a system for determining memorability of audio and/or visual content. The system of the invention includes one or more devices for presenting audio and/or visual content to an individual, and an apparatus for determining an extent of stimulation in one or both of the precuneus and the STS of the individual during exposure of the individual to the audio and/or visual content. For exposure of visual content, a screen may be used that is postionable in front of the individual. For exposure of audio content, loudspeakers or earphones may be used. Means for determining an extent of stimulation in one or both of the amygdale and the STS may include, for example, an FMRI apparatus, and processing means configured to analyze images obtained by the fMRI apparatus to score the neural stimulation of one or both of the amygdala and the STS.

Thus, in one of its aspects, the invention provides a system for determining memorability of one or more audio and/or visual content items, comprising:

(a) one or more presentation devices for presenting the audio and/or visual content items to an individual;

(b) a monitoring apparatus for monitoring a level of neural stimulation in one or both of the precuneus and the superior temporal sulcus (STS) of an

individual during exposure of the individual to the audio and/or visual content items, and generating data indicative of the level of stimulation of one or both of the amygdala and the STS; and

(c) a processing unit including a CPU, the CPU being configured to process data generated by the monitoring apparatus from one or more individuals to calculate one or more memorability scores of each of the one or more content items presented to the individual.

The audio and/or visual content may comprise, for example, marketing communication.

The monitoring apparatus may monitor neural stimulation only in the precuneus, or only in the STS, or in both of the precuneus and the STS. The monitoring apparatus may further monitor neural stimulation in the amygdale and calculation of the memorability score may further involve a level of stimulation in the amygdala.

The processing unit may further comprise a memory including one or more data files for storing data indicative of audio and/or visual content for presentation to an individual on the one or more presentation devices, and the CPU may be further configured to access the data of stored content and to present the accessed data on one or more of the presentation devices.

The monitoring apparatus may be an fMRI apparatus, in which case, the calculation of the memorability score may involve a blood oxygenation level dependent (BOLD) contrast determined by the fMRI apparatus.

The scoring may be a binary score, wherein a score of "nonmemorable" is assigned to content generating a level of neural stimulation in one or both of the precueneus and STS below a first threshold and a score of "memorable" is assigned to content generating a level of stimulation in one or both of the precuneus and STS above a second threshold. The calculation of the score of a content item may involve calculating an average of an extent of stimulation in one or more brain regions selected from the precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more content elements. The calculation of the score of a content item may assign a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited. The calculation of the score of a content item mat involve calculating an average of an

extent of stimulation in one or more brain regions selected from the precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more individuals. A score may be assigned that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited.

The system of the invention may further comprise display device, and the processing unit may be configured to display on the display device any one or more of data generated by the monitoring apparatus and scores calculated by the CPU.

In another of its aspects, the invention provides a method for determining memorability of one or more audio and/or visual content items, comprising:

(d) presenting the audio and/or visual content items to one or more individuals;

(e) determining a level of neural stimulation in one or more brain regions selected from the precuneus and the superior temporal sulcus (STS) in each of the one or more individuals during exposure of each individual to the audio and/or visual content items, and generating data indicative of the level of stimulation of one or both of the amygdala and the STS during presentation of each of the content items; and

(f) calculating one or more memorability scores of each of the one or more content items in a calculation involving the generated data.

The audio and/or visual content may comprise marketing communication.

In the method of the invention, only the precuneus may be monitored, or only the STS may be monitored. Alternatively, both the precuneus and the STS may be monitored. The method of the invention may further comprise monitoring the amygdale in which case, calculating the memorability scores may involve a level stimulation in the amygdala.

The method may further comprise storing data indicative of audio and/or visual content for presentation to an individual on the one or more presentation devices, and accessing the data of stored content to present the accessed data on one or more devices.

The monitoring may be performed using an fMRI apparatus, in which case calculation of the memorability score may involve a blood oxygenation level dependent (BOLD) contrast determined by the fMRI apparatus.

The scoring may be a binary score, wherein a score of "nonmemorable" is assigned to content generating a level of neural stimulation in one or more of the precueneus and STS below a first threshold and a score of "memorable" is assigned to content generating a level of stimulation in one or more of the precuneus and STS is above a second threshold. The calculation of the score of a content item may involve calculating an average of an extent of stimulation in one or more brain regions selected from the precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more content elements. The score of a content item may assign a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited. The calculation of the score of a content item may involve calculating an average of an extent of stimulation in one or more brain regions selected from the precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more individuals. The calculation of the score of a content item may assign a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited.

The method may further comprise a displaying on a display device any one or more of data generated by the monitoring apparatus and scores calculated by the CPU.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1a shows a composite GLM results for 15 individuals revealing a significant effect in the left and right STS and left and right precuneus for memorable ads in comparison to unmemorable ads, the insert shows a graph of the MRI response (% BOLD signal) for memorable ads (upper curve) and unmemorable ads (lower curve);

Fig. 1b shows GLM results for 15 individuals revealing a significant effect in the left and right amygdale;

Fig. 2 shows average time course in right (upper panel) and left (lower panel) STS activity of 15 individuals, revealing consistent differences between memorable and

unmemorable ads across all ads viewed (green background, memorable ads; blue background unmemorable ads);

Fig. 3 neural activation map for te STS (**Fig. 3a**) and the amygdala (**Fig. 3b**) using affect self-report measures as a predictor of memorability;

Fig. 4 shows superimpositon of the memorability and affect neural activation maps;

Fig. 5 shows the time course results for left (**Fig. 5a**) and right (**Fig. 5b**) STS for the two sessions that took place 18 months apart (upper curves-*memorable* ads; lower curves-*unmemorable* ads)

Fig. 6 shows a system for determining memorability of audio and visual content in accordance with one embodiment of the invention

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 6 shows a system **2** for determining an extent of memorability of audio and visual content, such as ads, in accordance with one embodiment of the invention. The system **2** comprises an apparatus for monitoring neural activity in one or both of the amygdala and the STS. In the embodiment of Fig. 6, the apparatus for monitoring the neural activity is an fMRI apparatus **4.** A table **6** allows an individual **8** to lie with his cranium **10** (shown in phantom) inside the fMRI apparatus **4.** The system **2** also comprises a screen **12** that is positioned so as to allow the individual **8** to view the screen while lying on the table **6.** A pair of speakers (not shown) or a set of earphones **14** allows exposure of the individual **8** to audio content while lying on the table **6.**

The system **2** further comprises a processing unit **16** that includes a CPU **18**. The CPU communicates with the monitoring apparatus **4** over a communication line **20**. The CPU **18** further communicates with the screen **12** over a communication line **22** and with the earphones **14** over a communication line **24**. The processing unit **16** also includes a memory **26** comprising one or more files **28** where data indicative of audio and visual content may be stored prior to presenting the content to the individual **8.** A user input device such as a keyboard **30** or a computer mouse **32** is used to input data into the memory, such a data identifying the subject **8** or data relating to the content to which the individual **8** is to be exposed. Processing of data provided by the monitoring

apparatus is carried out by the CPU **18** and may be stored in one of the files **28** and displayed on a display device, such as a monitor **34**.

The CPU **18** is configured to access content data stored in the memory **26** and to present to the individual **8** a predetermined sequence of content. The sequence of content may include, for example, one or more ads. Audio content is presented to the individual **8** by the CPU **18** over the communication line **24** to the earphones **14**. Visual content is presented to the individual **8** by the CPU **18** on the screen **12** over the communication line **22**. Visual and audio content may be presented simultaneously or in alternation. During presentation of the content to the individual **8,** neural activity in one or both of the amygdale and the STS is monitored by the neural activity monitoring apparatus **4.** Data collected by the apparatus **4** are transmitted to the processing unit **16** over the communication line **20** and are initially stored in one of the data files **28**.

The CPU is configured to access the data received from the apparatus **4** and to determine a level of neural activity in one or both of the STS and the precuneus.

EXAMPLE

Methods

Fifteen healthy individuals (7 females, 8 males, 22-34 years old) participated in the study; all of whom had normal or corrected-to-normal vision. Each provided written informed consent. They received $40 each for their participation. The individuals were exposed to commercials shown on television in Israel during the years 2005-2006. Twenty commercials were used 10 of which were previously classified as *"memorable"* while the other 10 were previously classified as *"unmemorable"* based on a national memory test derived from a national survey conducted every two weeks on independent random samples generating indices of all TV advertising campaigns. To control for exposure tendency, the media expenditure of each of the selected commercials was in the range of: $750K-1M. The ads portrayed a variety of products and services, among them a convenience store, insurance, soft drinks, beer, coffee, cars, perfume, cosmetics, chewing gum, baby food, media and Internet services, fashion, health services, snacks, detergents, and tourism.

The characteristics of neural activity during exposure to the two types of commercials (memorable and unmemorable) were determined using fMRI. The fMRI

measures were integrated with self-report measures, assessing individuals' reactions to each ad. The self-report measures included ad liking, product involvement, affective response to the ad, cognitive processing, and purchase intention. These combined measures were used to determine the meaning of the observed neural activity.

The ads were projected via an LCD projector onto a tangent screen positioned over the subject's forehead, and were viewed through a tilted mirror. Auditory signals were controlled for volume and were delivered via earphones, which minimized exposure to the scanner noise.

During the experiment, the 20 ads were randomly presented with a 10-second blank gray screen between them and a 30-second blank gray screen at the beginning and end of the series. The blank gray screen was used as the activation baseline. Individuals were scanned with fMRI during the entire time of their exposure to the ads. They were asked to view the ads, and were not given any specific instructions. When the scanning was over, each individual was requested to view all the ads again (outside the scanner), and to complete a questionnaire measuring their reactions to the ad after viewing each one of them. The questionnaire included five items: their liking of the ad (the extent to which they liked the ad); their involvement with the advertised product (the extent to which the advertised product/service was relevant to them); the intensity of affective response evoked by the ad (the extent to which the ad induced any kind of emotional arousal, i.e., positive or negative); the cognitive processing evoked by the ad (the extent to which the commercial made them engage in thinking about either the product, the selling proposition, or the commercial's attributes); and, their purchase intentions (the extent to which the next time they needed a similar product/service they would consider the advertised product/service). All items used a 7-point scale (1 = not at all; 7 = very much). Due to technical considerations pertaining to the availability of the scanner, data were collected in two separate sessions that took place eighteen months apart.

A high field MRI scanner (3T) equipped with a standard head coil was used. Individuals underwent a detailed high resolution anatomical scan, followed by the functional scan. Functional imaging using blood oxygenation level dependent (BOLD; Kwong et al. 1992) contrast was obtained with gradient-echo echo-planar imaging (EPI) sequence (TR = 2500, TE = 35, flip angle = 90°, field of view 20 × 20 cm2, matrix size 64 × 64). The scanned volume included 38 nearly-axial slices of 3 mm thickness and 0

mm gap. A whole brain spoiled gradient (SPGR) sequence was acquired on each individual to allow accurate cortical segmentation, reconstruction, and volume-based statistical analysis. T1-weighted high-resolution (1x1x1 mm) anatomical images and a 3-dimensional (3D) spoiled gradient-echo sequence were acquired on each subject.

Data were analyzed using BrainVoyager software. The first three volumes of each scan were discarded, due to the hemodynamic nature of brain response. Images were superimposed on 2D anatomical images and incorporated into the 3D data sets through trilinear interpolation. The complete data set was transformed into Talairach space. Pre-processing included 3D motion correction, linear trend removal, slice scan time correction, and spatial smoothing using a Gaussian filter of 6 mm full width at half maximum value (FWHM). The cortical surface was reconstructed from the 3D-SPGR scan. The procedure included segmentation of the white matter using a grow-region function, the smooth covering of a sphere around the segmented region, and the expansion of the reconstructed white matter into the gray matter. The surface was then unfolded, cut along the calcarine sulcus, and flattened. Transforming all the data into the Talairach space allowed cross-individual comparisons.

To assess the selective activations and de-activations across all individuals, a standard general linear model (GLM) analysis was applied using the memorability predictor (0 = non memorable, 1 = memorable) as a regressor. A box-car predictor with a hemodynamic delay of 3 seconds was constructed, and the model was independently fitted to the time course of each voxel. A regression coefficient was calculated for each predictor using the least-squares algorithm. After computing the coefficients for all regressors, a two-tailed contrast test of the two conditions was performed. The results were corrected for multiple comparisons using false discovery rate (FDR) control.

RESULTS

Fig. 1a shows the results of the GLM analysis in the sub-cortical structures described above for the two types of ads. The results revealed a significant effect in the left and right STS for memorable ads in comparison to unmemorable ads. The insert to Fig.1a shows a graph of the MRI response (% BOLD signal) for memorable ads (upper curve) and unmemorable ads (lower curve), which revealed significant differences in neural activation in the amygdala between memorable and unmemorable ads [$q(FDR) < .05$]. Fig. 1b shows the GLM results in the cortical structures, presented on unfolded

hemispheres. The results shown in Fig. 1b revealed significant differences in the overall cortical neural activations between memorable and unmemorable ads [q(FDR) < .05]. The difference in activation between the memorable and the unmemorable stimuli was not distributed randomly across the cortex. Rather, a consistent dissimilarity in the STS was observed between memorable and unmemorable ads.

To assess whether the differences in neural activation between the memorable and unmemorable ads were consistent across every ad each of the two groups of ads, variations in BOLD activity in the STS during exposure time was studied. Fig. 2 shows the average time course in BOLD activity in right (upper panel) and left (lower panel) STS activity of the 15 individuals upon viewing each of the memorable adds (light background) and each of the unmemorable adds (dark background). The results reveal a consistently higher level of activity during exposure to ads in the memorable group compared to those in the unmemorable group.

To further explore which specific factors underlie these differences in amygdala and STS activation, the self-report measures were used including ad liking, involvement in the product, affective response, cognitive processing, and purchase intentions. To assess which of these factors is associated with memorability, each of these factors was compared across the two groups of ads. The examination revealed that the only significant measure associated with ad memorability is the affective response to the ad (t (17) = 3.099, p < .05). Analyses of all other factors revealed insignificant differences between the groups, indicating that none of the other factors (ad liking, involvement in the product, cognitive processing, or purchase intentions) can explain differences in ad memorability.

To assess whether differences in affective responses can account for the differences in amygdala and STS activation, a psychophysical multi GLM analysis was conducted by median splitting the affective response self-report measures and using it as a regressor, and the differences in the neural activation of various brain regions across the two conditions: high versus low affective response were examined. The results are shown in Fig. 3 which shows the GLM results for psychophysical analysis based on affect self-report measures as a predictor for neural activations. The results show a significant effect in the left and right amygdala (Fig. 3a) and in the STS (Fig. 3b) for affect that is consistent with the memorability effect presented above in the amygdala and STS.

Fig. 4 shows the superimposition of the two neural maps memorability and affective effect. These results show that differences in neural activations between memorable and unmemorable ads in the STS are associated with the affective responses the ads generated at the individual's level.

This study used real ads, and thus they could not be fully controlled for all physical characteristics. When a statistical map of the memorable versus unmemorable contrast was overlaid on the cortical mantle, no significant clusters were evident in the primary sensory cortices (see Fig.1b, $q(FDR)<0.05$). This pattern of results indicates that the memory/affect effect cannot be explained by the physical low-level features of the ads.

Further examination of the stimuli reveals differences in length between the various ad groups, with a longer average time-span of the memorable compared to the unmemorable group ($M_{memorable}$ = 28.2sec, $M_{unmemorable}$ = 20.9sec groups; see Fig. 2). To assess whether these differences in duration have an effect on the intensity of the stimulation, the results were analyzed while controlling for ad length. The stimuli were divided into two random conditions, creating a chimera multi GLM analysis, which revealed no significant difference between two randomly selected groups of commercials [$q(FDR) > .05$]. We then divided all stimuli (memorable and unmemorable) into two groups: long and short. This was done based on median splitting at 20 seconds, such that the short ads group contained nine ads ranging from 9-20 seconds, and the long ad group contained nine ads ranging from 24-39 seconds in length. A multi GLM analysis was then conducted that revealed insignificant differences between the two ad length conditions [$q(FDR) > .05$]. Two separate multi GLM analyses were conducted on the two groups of ads (memorable and un-memorable), splitting each group based on ad length (i.e., memorable long vs. memorable short and un-memorable long vs. un-memorable short, with 29 seconds as the median for the memorable ads and 19 seconds as the median for the un-memorable ads). No significant differences between the two length groups were observed, neither for the memorable condition nor for the un-memorable condition [$q(FDR) > .05$]. Finally, taking only those commercials balanced in length from the memorable and un-memorable commercials groups (five commercials from the memorable group and five from the un-memorable group) and an additional multi GLM analysis was performed on

these smaller-scale stimuli groups. Significant differences between memorable and un-memorable commercials [q(FDR) < .05] were found, indicating that the neural activation effect is not contingent upon ad length.

Another factor in this study was the use of real ads that were broadcasted nationally prior to the execution of the study. Thus, variations in familiarity of the individuals with the different ads might be involved in the differences observed in neural activation. The study was conducted in two sessions that took place eighteen months apart. Assuming that individuals in the first session were more familiar with the ads compared to individuals in the second session, cortical memorability effect in the two sessions were compared. This analysis revealed substantial similarities in neural activation patterns of the left STS (Fig. 5a) and the right STS (Fig. 5b) between the first and second session (Fig. 5), suggesting that variations in familiarity of the individuals with the different ads is not a significant factor in the differences observed in neural activation.

CLAIMS:

1. A system for determining memorability of one or more audio and/or visual content items, comprising:

(a) one or more presentation devices for presenting the audio and/or visual content items to an individual;

(b) a monitoring apparatus for monitoring a level of neural stimulation in one or both of the precuneus and the superior temporal sulcus (STS) of an individual during exposure of the individual to the audio and/or visual content items, and generating data indicative of the level of stimulation of one or both of the precuneus and the STS; and

(c) a processing unit including a CPU, the CPU being configured to process data generated by the monitoring apparatus from one or more individuals to calculate one or more memorability scores of each of the one or more content items presented to the individual.

2. The system according to Claim 1 wherein the monitoring apparatus monitors neural stimulation in the precuneus.

3. The system according to Claim 1 wherein the monitoring apparatus monitors neural stimulation in the STS.

4. The system according to Claim 1 wherein the monitoring apparatus further monitors neural stimulation in the amygdale and calculation of the memorability score further involves a level of stimulation in the amygdala.

5. The system according to any one of the previous claims wherein the processing unit further comprises a memory including one or more data files for storing data indicative of audio and/or visual content for presentation to an individual on the one or more presentation devices, and wherein the CPU is further configured to access the data of stored content and to present the accessed data on one or more of the presentation devices.

6. The system according to any one of the previous claims wherein the monitoring apparatus is an fMRI apparatus.

7. The system according to Claim 6 wherein the calculation of the memorability score involves a blood oxygenation level dependent (BOLD) contrast determined by the fMRI apparatus.

8. The system according to any one of the previous claims wherein the audio and/or visual content comprises marketing communication.

9. The system according to any one of the previous claims wherein the scoring is a binary score, wherein a score of *"nonmemorable"* is assigned to content generating a level of neural stimulation in one or both of the precueneus and STS below a first threshold and a score of *"memorable"* is assigned to content generating a level of stimulation in one or both of the precuneus and STS above a second threshold.

10. The system according to any one of the previous claims wherein the calculation of the score of a content item involves calculating an average of an extent of stimulation in one or more brain regions selected from the precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more content elements.

11. The system according to Claim 10 wherein the calculation of the score of a content item assigns a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited.

12. The system according to any one of Claims 1 to 9 wherein the calculation of the score of a content item involves calculating an average of an extent of stimulation in one or more brain regions selected from the precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more individuals

13. . The system according to Claim 12 wherein the calculation of the score of a content item assigns a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited.

14. The system according to any one of the previous claims further comprising a display device, and wherein the processing unit if configured to display on the display device any one or more of data generated by the monitoring apparatus and scores calculated by the CPU.

15. A method for determining memorability of one or more audio and/or visual content items, comprising:

(a) presenting the audio and/or visual content items to one or more individuals;

(b) determining a level of neural stimulation in one or more brain regions selected from the precuneus and the superior temporal sulcus (STS) in each of the one or more individuals during exposure of each individual to the audio and/or visual content items, and generating data indicative of the level

of stimulation of one or both of the precuneus and the STS during presentation of each of the content items; and

(c) calculating one or more memorability scores of each of the one or more content items in a calculation involving the generated data.

16. The method according to Claim 14 wherein the precuneus is monitored.

17. The method according to Claim 14 wherein the STS is monitored.

18. The method according to Claim 14 further comprising monitoring the amygdale and calculating the memorability scores involves a level stimulation in the amygdala.

19. The method according to any one of Claims 1 to 18 further comprising storing data indicative of audio and/or visual content for presentation to an individual on the one or more presentation devices, and accessing the data of stored content to present the accessed data on one or more of the presentation devices.

20. The method according to any one of Claims 1 to 19 wherein the monitoring is performed using an fMRI apparatus.

21. The method according to Claim 20 wherein the calculation of the memorability score involves a blood oxygenation level dependent (BOLD) contrast determined by the fMRI apparatus.

22. The method according to any one of Claims 1 to 21 wherein the audio and/or visual content comprises marketing communication.

23. The method according to any one Claims 1 to 22 wherein the scoring is a binary score, wherein a score of *"nonmemorable"* is assigned to content generating a level of neural stimulation in one or more of the precueneus and STS below a first threshold and a score of *"memorable"* is assigned to content generating a level of stimulation in one or more of the amygdale, precuneus and STS above a second threshold.

24. The method according to any one of Claims 1 to 23 wherein the calculation of the score of a content item involves calculating an average of an extent of stimulation in one or more brain regions selected from the precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more content elements.

25. The method according to Claim 24 wherein the calculation of the score of a content item assigns a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited.

26. The method according to any one of Claims 15 to 25 wherein the calculation of the score of a content item involves calculating an average of an extent of stimulation in one or more brain regions selected from the, precuneus and the STS of one or more pairs of an individual and a content item, for each of one or more individuals.

27. The method according to Claim 26 wherein the calculation of the score of a content item assigns a score that is correlated with the number of standard deviations above or below the average of the extent of stimulation that the content element elicited.

28. The method according to any one of Claims 15 to 27 further comprising a displaying on the display device any one or more of data generated by the monitoring apparatus and scores calculated by the CPU.

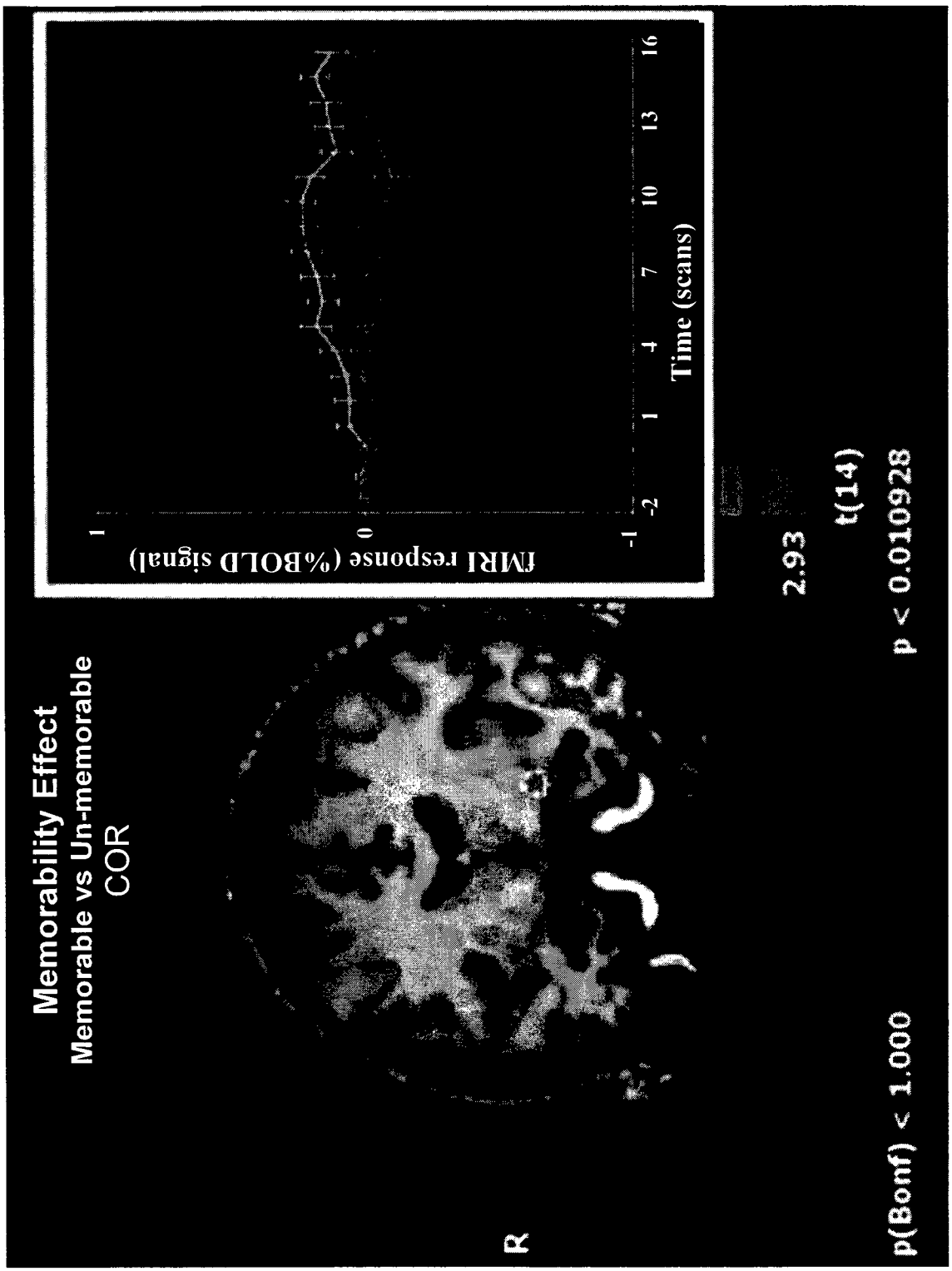
Memorability Effect
Memorable vs Un-memorable
COR
R
p(Bonf) < 1.000
2.93
t(14)
p < 0.010928
fMRI response (%BOLD signal)
1
0
-1
-2
1
4
7
10
13
16
Time (scans)

FIG. 1A

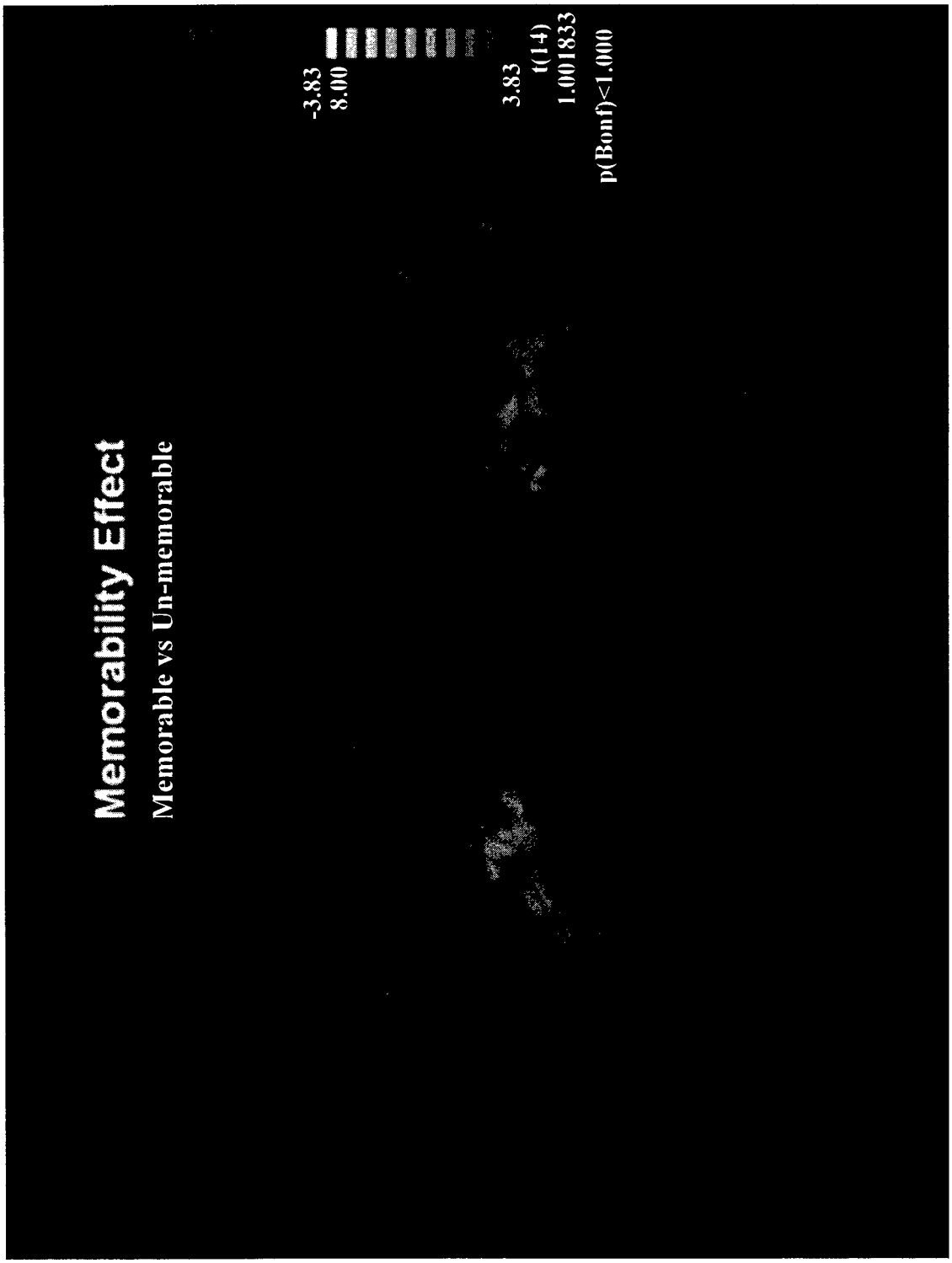
Memorability Effect
Memorable vs Un-memorable
-3.83
8.00
3.83
t(14)
1.001833
p(Bonf)<1.000

FIG. 1B

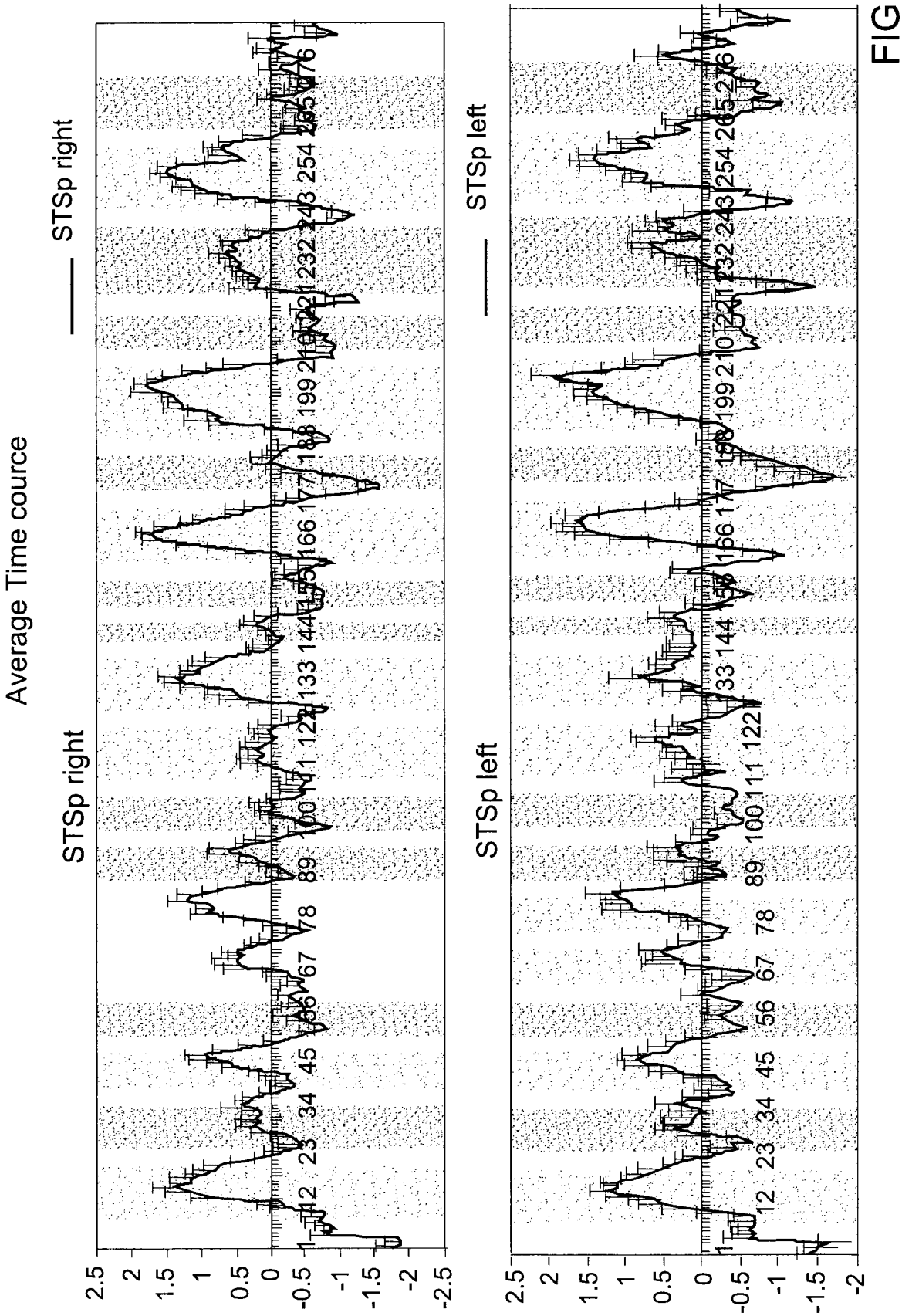
Average Time cource
STSp right
STSp left
STSp right
STSp left

FIG. 2

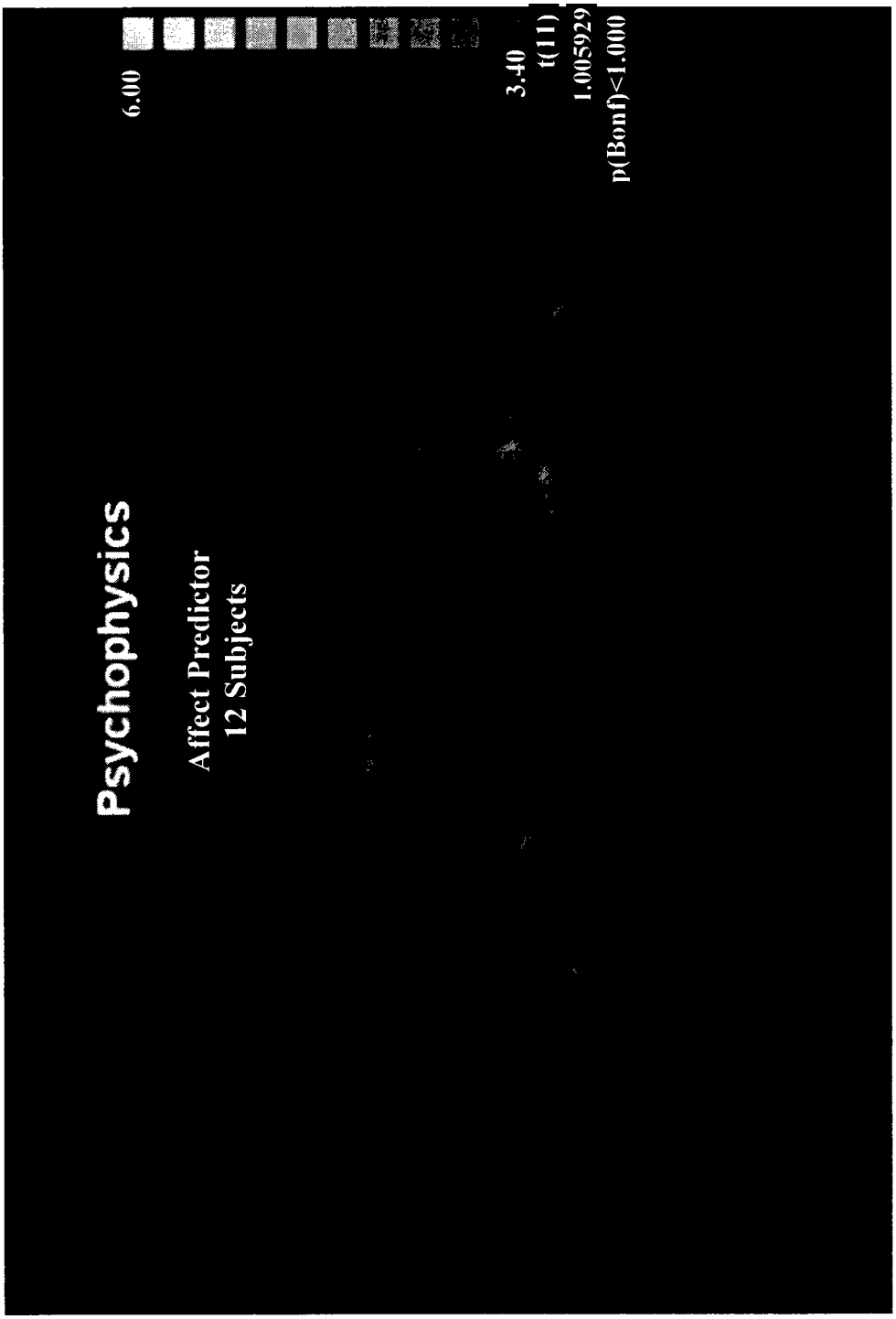
Psychophysics
Affect Predictor
12 Subjects
6.00
3.40
t(11)
1.005929
p(Bonf)<1.000

FIG. 3A

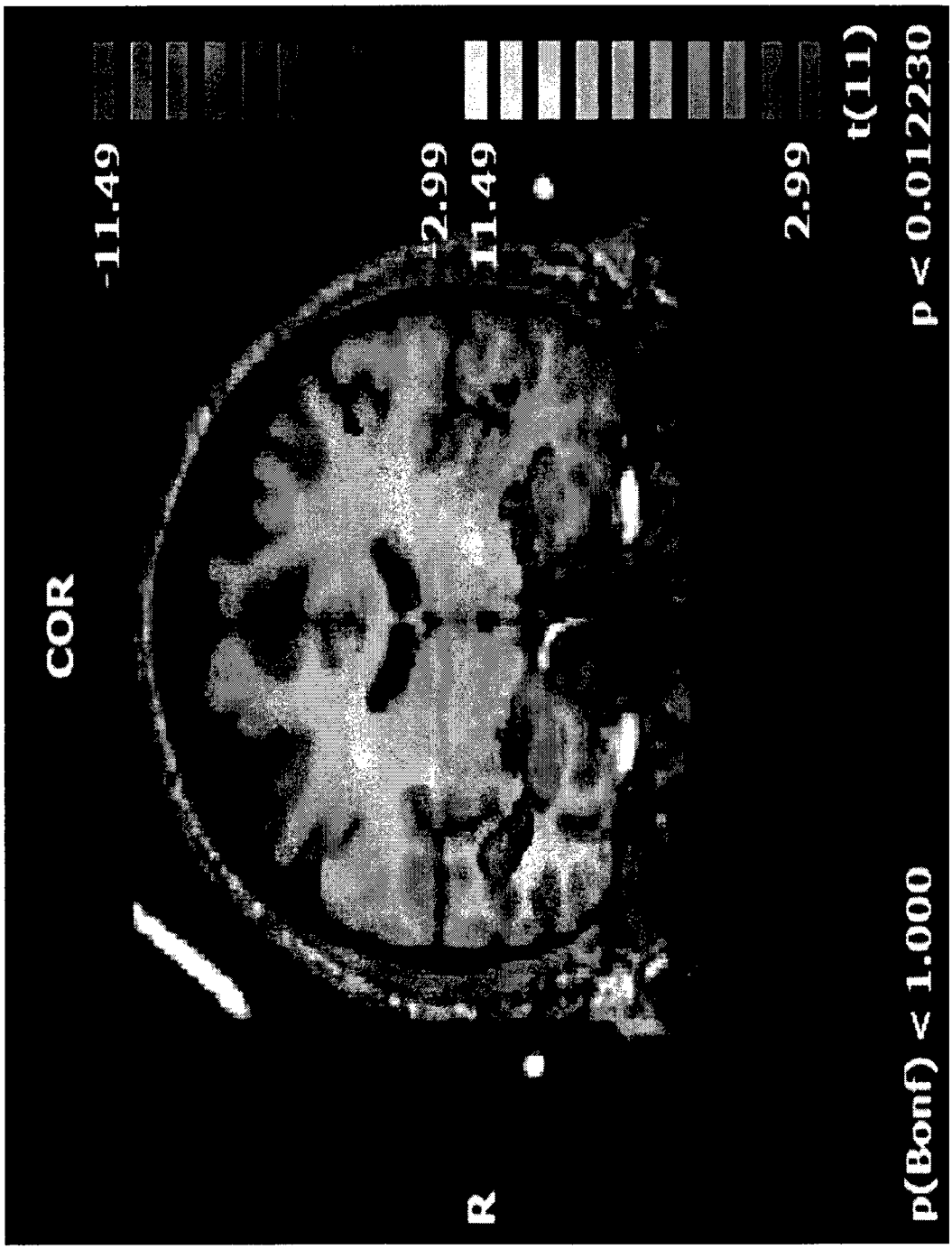

FIG. 3B

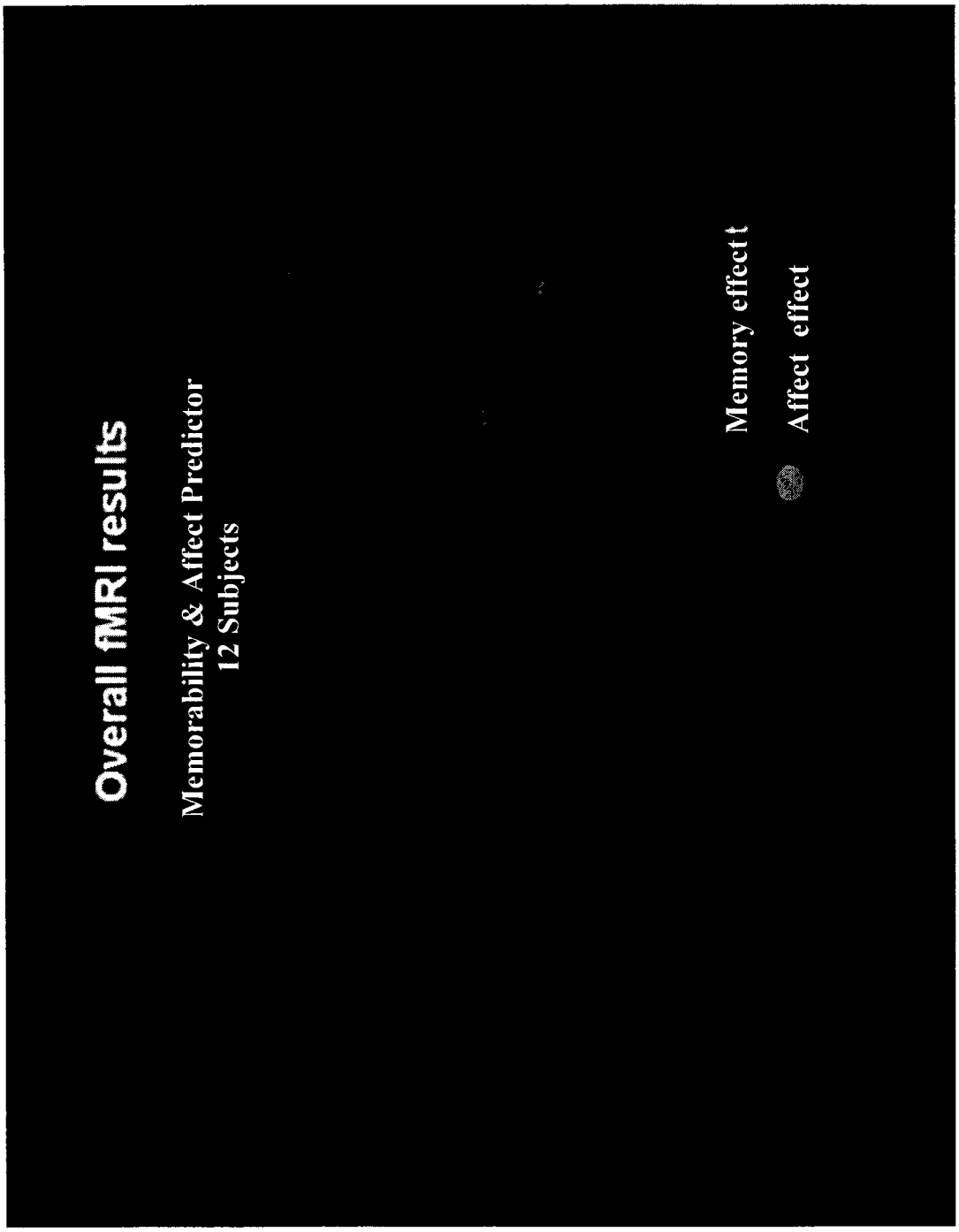
Overall fMRI results
Memorability & Affect Predictor
12 Subjects
Memory effect t
Affect effect

FIG. 4

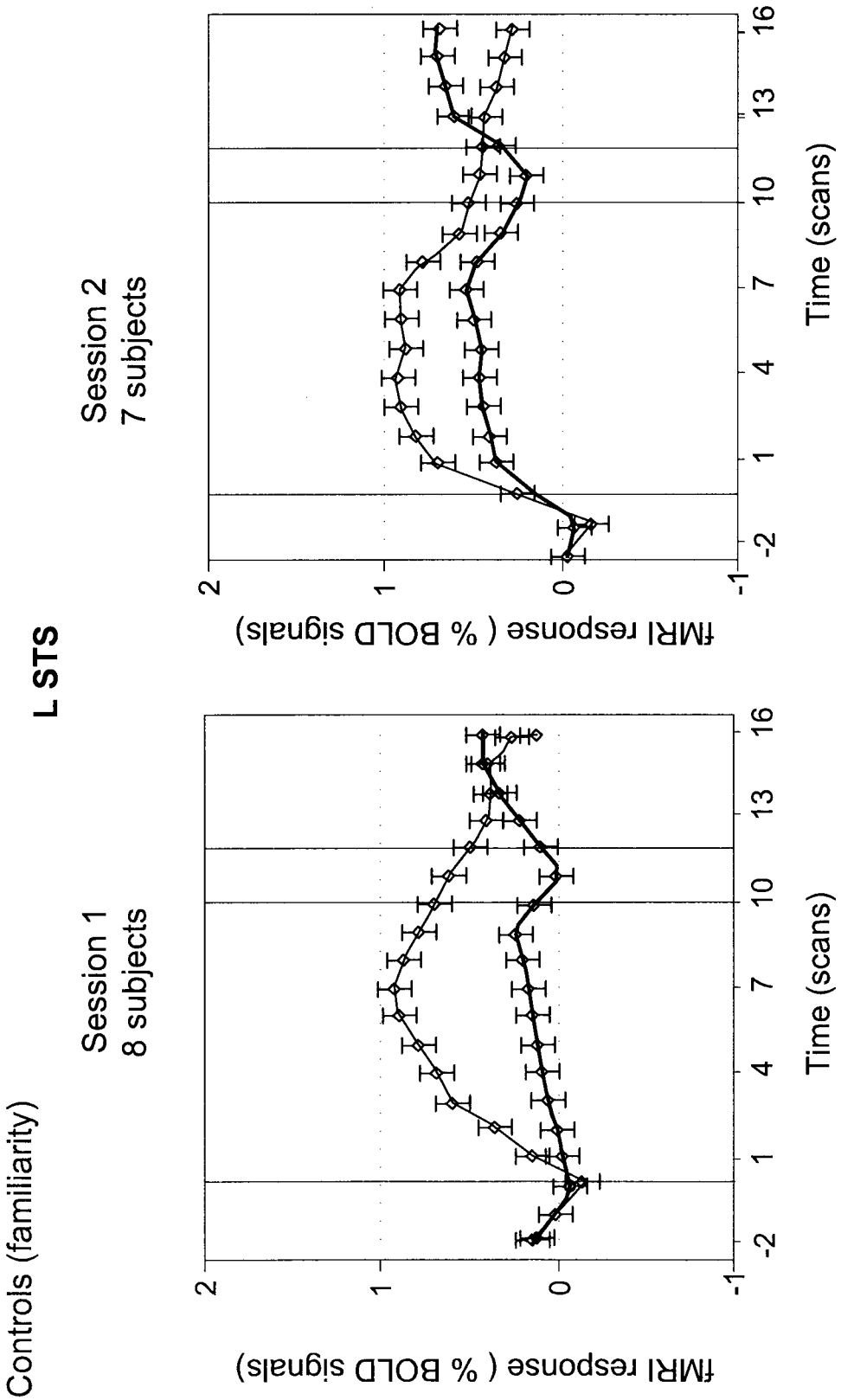
Controls (familiarity)
L STS
Session 1
8 subjects
Session 2
7 subjects
fMRI response (% BOLD signals)
Time (scans)
2
1
0
-1
-2
1
4
7
10
13
16

FIG. 5A

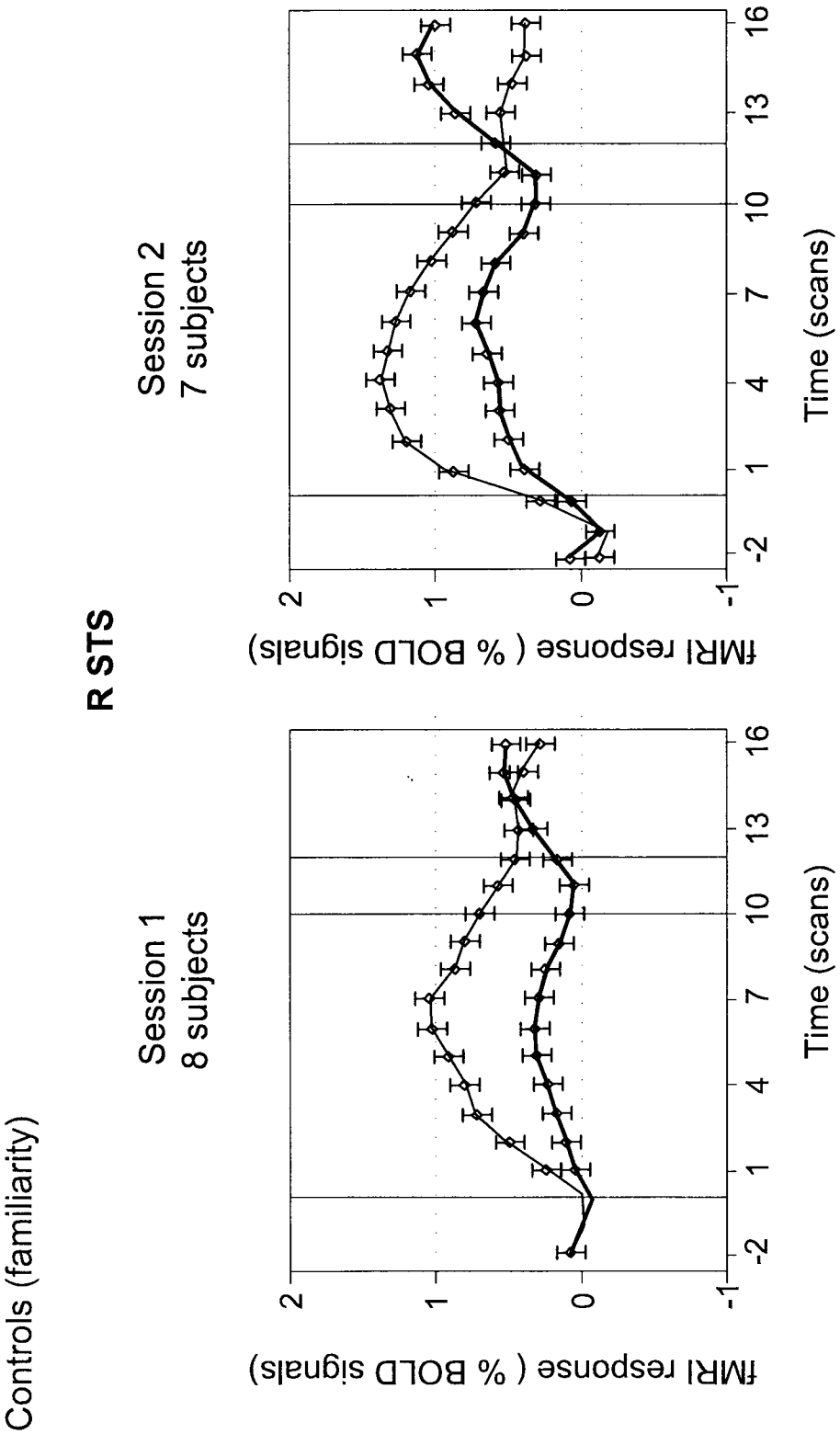
Controls (familiarity)
R STS
Session 1
8 subjects
Session 2
7 subjects
fMRI response (% BOLD signals)
Time (scans)
2
1
0
-1
-2
1
4
7
10
13
16

FIG. 5B

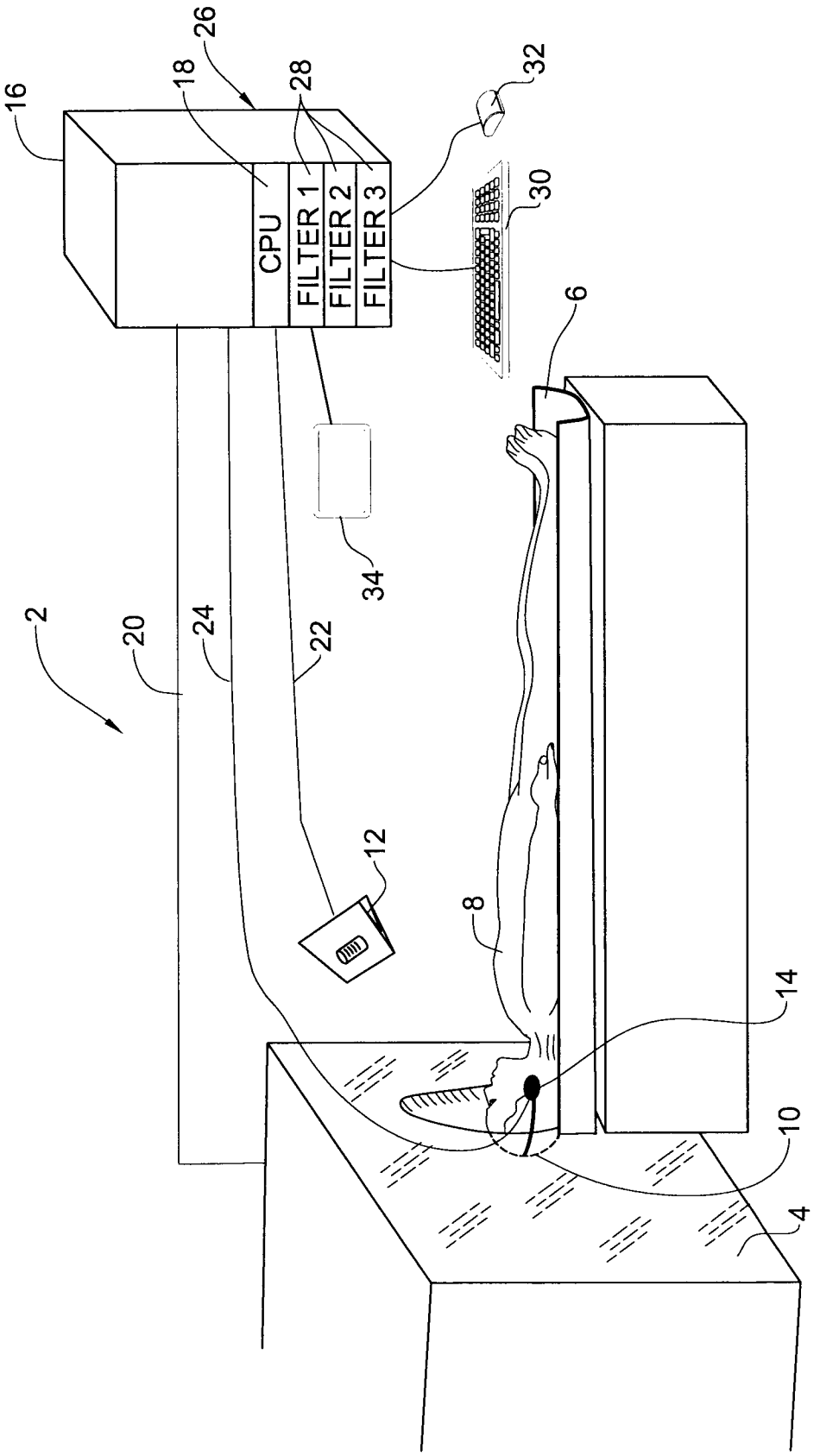
26
18
28
32
16
CPU
FILTER 1
FILTER 2
FILTER 3
30
6
34
2
20
24
22
12
8
14
10
4

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2011/000326

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/055
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B G06Q G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LEIBENLUFT: "Mothers' neural activation in response to pictures of their children and other children", BIOLOGICAL PSYCHIATRY, vol. 56, no. 4, 1 January 2004 (2004-01-01), page 225, XP55004311, ISSN: 0006-3223	1-4,6,7, 15-18, 20,21
Y	abstract * Methods and Materials p. 226-227 * * Discussion p. 227-231 *	5,8-14, 19,22-28
Y	US 6 415 048 B1 (SCHNEIDER MICHAEL BRET [US]) 2 July 2002 (2002-07-02) column 3, line 43 - column 5, line 41	5,8-14, 19,22-28

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 August 2011	23/08/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Trachterna, Morten

2

Form PCT/ISA/210 (second sheet) (April 2005)

International application No
PCT/IL2011/000326

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/111652 A1 (UNIV NEW YORK [US]; HASSON URI [US]; MALACH RAFI [IL]; HEEGER DAVID [U) 11 September 2009 (2009-09-11) paragraphs [0006] - [0010]	1-4,6,7, 15-18, 20,21
A	KENNING ET AL: "Applications of functional magnetic resonance imaging for market research", QUALITATIVE MARKET RESEARCH: AN INTERNATIONAL JOURNAL, vol. 10, no. 2, 1 January 2007 (2007-01-01), pages 135-152, XP55004314, ISSN: 1352-2752 * Methodologcal issues relating to fMRI data analysis p. 140-143 *	1,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IL2011/000326

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6415048 B1	02-07-2002	NONE	
WO 2009111652 A1	11-09-2009	US 2011161011 A1	30-06-2011