HEMISPHERIC MEMORY FOR SURREALISTIC VERSUS REALISTIC PAINTINGS

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INTRODUCTION

Pictures, on the whole, make an excellent tool for studying how the mind is organized in the brain, because, unlike linguistic material, they can tap a broad and diverse range of long-term semantic memory in both hemispheres. Whereas the left hemisphere specializes in language and the right is severely limited in that area, meaningful pictures have been shown to be processed in both hemispheres. In the present study we used pictures as stimuli to investigate processing of art works as well as hemispheric processing of art works in conjunction with linguistic labels.

Currently, there is remarkable paucity of systematic data about the cognitive and brain mechanisms underlying the perception and production of art works. The work that has been published in the area of art and brain has dealt largerly with comparing pre- and post-brain damage in the same artist (see Gardner, 1974, 1982, for review) or in the area of aesthetic preference in hemi-field testing of normal subjects (e.g., Levy, 1976).

However, the question of the hemispheric status of the way in which different art genres (or styles) treat reality is inherently interesting and theoretically important to neuropsychology, philosophy of art and of language. Here, we controlled the type of pictures used as stimuli by studying "surrealistic" versus "realistic" pictures, all painted by professional artists, because they treat reality in what appears to be diametrically opposed ways: The surrealistic paintings we chose include configurations which violate some physical laws of reality while what the realistic paintings show reflects these laws correctly. The hemispheric status of these two art types has not been studied previously in either normal or brain-damaged populations.

In addition, we were after an aspect of the hemispheric nature of the relationships between language and art. This question, too, has gone largely unstudied systematically. One can certainly find reports and discussions of artists with acquired brain-damage who have become impaired in their language skills but not in their artistic production skills (Alajouanine, 1948; Vajda, 1982) or of artists who have lost their artistic but not their language skills (cited in Schweiger, 1988), implying that the two could be subserved by separate anatomical and functional systems (see Gardner, 1982, and Schweiger, 1988, for reviews). Yet, art and language are normally encountered simultaneously in displays of art

objects when artists commonly assign a name to each of their works. In some well-documented cases, e.g. Whistler or Magritte (Hammacher, 1973), the artists gave much thought to the appropriate names for their paintings. This suggests that some artists assume that a certain relationship exists between the picture and the name. For instance, Magritte has commented that "The title of a picture is an image made up of words. It joins up with a painted image... (they) enrich and refine thought (Torczyner, 1979, p. 130)". If a subtle relationship does exist between those two aspects of an art work it is reasonable to investigate its nature in the context of cognitive organization in the brain.

Thus, one purpose of the present study was to determine whether or not a certain type of such a relationship exists, namely, between processing paintings and processing their titles. In particular, we wanted to find out the hemispheric nature of this relationship.

The titles for the paintings were created so that we could control their linguistic meaning. Thus, both metaphoric and literal descriptions of the paintings were constructed. These two linguistic forms were chosen because we considered surrealistic painting and metaphors to be anything but literal or commonplace descriptions of the real-world. Thus, we thought of a metaphoric title as being analogous to a surrealistic picture and of a literal title, to a realistic picture. Stimulus pairs in which one member was a pictorial representation and the other a linguistic one were constructed. We then proceeded to measure the effects of such pairing on memory in each hemisphere. By way of background, the following description of earlier studies is directly relevant to our investigation.

(1) Previous evidence suggests that pictorial arrangements that are incongruous (defined as those that do not represent any known arrangement in the real world) are better processed when initially presented to the left hemisphere than to the right: With complete commissurotomy patients, stimuli representing features in the human face which were rearranged systematically within an outline of a face so that an eye was substitued for a nose, lips substituted for an eye, and so on, were recognized for what they are only by the left hemisphere while normally positioned features in the human face were recognized by both hemispheres (Zaidel, 1984, 1988 b). Similarly, scenes with normal organization except for one detail that rendered them incongruous with respect to the real world were remembered better by the left than by the right hemisphere in normal subjects (Zaidel, 1988 a). The results were interpreted within the cognitive psychological framework of schema-based knowledge and within the clinical neurological framework of agnosia. They were taken to reflect asymmetries in storage/retrieval of word-knowledge, and, specifically, to reflect left hemisphere specialization in processing "incongruity" in depictions of common physical percepts.

(2) Howard Gardner has been the first to provide a general review of the topic of art and brain, referring especially to lessons learned from brain-damaged patients (Gardner, 1974, 1982). In addition, an experiment by Winner and Gardner (1977) investigated the issue of hemispheric processing of metaphors and their pictorial representations. They tested the ability of left and right brain-damaged patients to understand the aural presentation of familiar metaphoric expressions and measured both non-verbal (pictorial) and verbal responses. The pattern of results for the right brain-damaged group demonstrated poor understanding of metaphors as judged from responses on the pictorial test but a high-level (85% correct) understanding of metaphors on the verbal interpretation test. The opposite dissociation was observed for the left hemisphere group (all aphasics). The authors concluded that each hemisphere makes characteristic contribution to understanding of metaphors. However, they stressed that right brain damaged patients had an abnormal appreciation of certain pictures, i.e., they were unamused by the literal depictions of the metaphors, implying thereby that the damage created a deficit in appreciating pictorial representations of metaphoric verbal expressions.

In the present investigation, 3 experiments were conducted with normal subjects in a combined recognition memory and hemi-field paradigm. In Experiment 1, we set out to determine whether or not any asymmetries are present in remembering surrealistic versus realistic paintings. Next, we assigned titles to these painting and probed memory for titles only in Experiment 2, and for pictures only in Experiment 3.

Experiment 1

In this experiment we looked for the presence or absence of hemispheric differences in memory for surrealistic versus realistic pictures. Subjects viewed the two types in a mixed series and were then tested on their ability to recognize them.

Materials and Method

Subjects

Fifteen normal right-handed subjects (8 females and 7 males) participated. They were undergraduate student who volunteered in exchange for partial course credit for their introductory psychology course. None was an art major and all were naive about the paintings and their artists.

Apparatus

A projector tachistoscope equipped with electro-mechanical shutters (G1167) was used to back project the stimuli unto a screen. A digital clock/counter (Gerbrands G1270/G1271) measuring latency to the nearest millisecond was started upon stimulus onset. It stopped the count when the subject responded manually on a two-button response key. Both accuracy and reaction time (RT) were recorded manually by the experimenter.

Stimuli

Colored pictorial stimuli were selected from art books (see sources in Appendix) according to whether or not they portrayed "surrealistic" or "realistic" depictions of reality. The logic behind the choices was as follows: The surrealistic pictures should portray impossible representation of objects in the known world while the realistic pictures should represent the known world correctly. Both types were roughly equal in complexity and in subject-matter. We were interested more in the real/unreal dichotomy than in whether or not a given artist belonged to one art "School" or another. For instance,

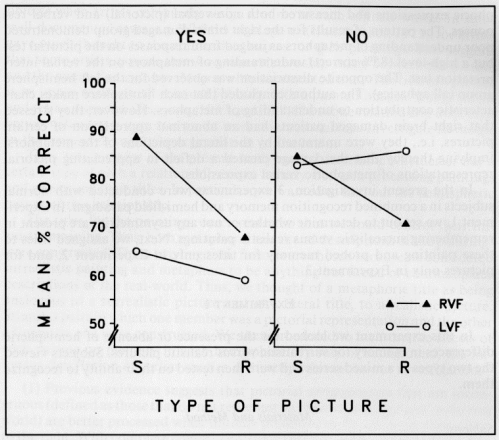

Fig. 1 – *Experiment 1. Mean percent correct for positive responses (left panel) and negative (right panel) are shown. S = surrealistic; R = realistic.*

even though Magritte and Delveaux are both considered by art historians to be part of Surrealism, they painted realistic pictures as well. In the study-list there were 12 surrealistic and 12 realistic pictures. For the decoys, there were 24 pictures, half surrealistic and half realistic.

Procedures

Each subjects sat in front of the screen at a distance of 18 inches away. A chin-rest was used to ensure a uniform distance. During the study phase the 24 pictures were projected centrally for a duration of 4 sec each. Subjects were simply instructed to remember each picture for a subsequent test of their memory. Then, after the last stimulus wash shown, memory was probed in a recognition paradigm as follows: A red dot affixed to the screen served as a focus point for the eyes. The subject was instructed to fixate his/her gaze on the dot throughout the test phase. With the gaze thus fixated, probes were projected either in the left (LVF) or right (RVF) visual half-fields (VHF) in a pseudo-random order for an exposure duration of 100 msec per probe. The near edge of the lateralized image on the screen with respect to the fixation point was 2.9 degrees. The positive and negative trials were inter-mixed within the tests series. The subject's task was to indicate "yes" or "no" with a button-press (with the index finger) whether or not the picture was seen previously.

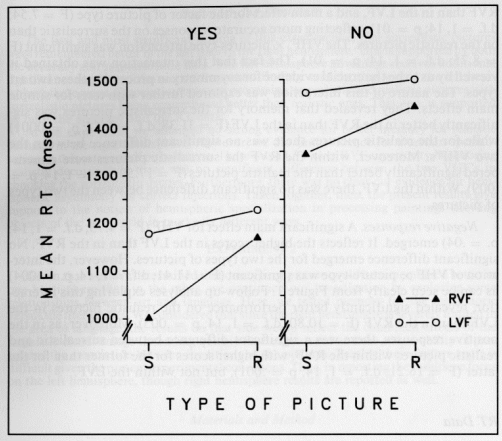

Fig. 2 – *Experiment 1. Mean RT for positive and negative responses. S = surrealistic; R = realistic.*

Within each sex group, both button symmetry and the pressing hand (left versus right) were counterbalanced.

Results

Both accuracy and reaction time (RT) of correct responses were analyzed. The accuracy data are plotted in Figure 1 and RT data are shown in Figure 2. There were no significant differences in scores between the sexes or between the hands. Thus, the results were collapsed across these variables. Analysis of variance (ANOVA) with repeated measures for the factors of visual half-field (VHF) (LVF, RVF) and picture-type (surrealistic, realistic) was applied separately to the accuracy and RT data.

Accuracy Data

Positive responses. The ANOVA revealed a main effect for the factor of VHF ($F = 20.89$; d.f. $= 1, 14$; $p = .0004$) reflecting more accurate responses in the

RVF than in the LVF, and a main effect for the factor of picture type ($F = 7.54$; d.f. $= 1, 14$; $p = .01$), reflecting more accurate responses on the surrealistic than on the realistic pictures. The VHF $\times$ pictures-type interaction was significant ($F = 8.75$; d.f. $= 1, 14$; p. $= .01$). The fact that this interaction was obtained is viewed by us to be the crucial evidence for asymmetry in processing these two art types. The nature of this interaction was explored further with tests for simple main effects. They revealed that memory for the surrealistic pictures was significantly better in the RVF than in the LVF ($F = 31.38$; d.f. $= 1, 14$; p. $= .0001$) while for the realistic pictures there was no significant difference between the two VHF's. Moreover, within the RVF the surrealistic pictures were remembered significantly better than the realistic pictures ($F = 17.50$; d.f. $= 1, 14$; p. $= .009$). Within the LVF, there was no significant difference between the two types of pictures.

Negative responses. A significant main effect for VHF ($F = 4.73$; d.f. $= 1, 14$; p. $= .04$) emerged. It reflects the higher scores in the LVF than in the RVF. No significant difference emerged for the two types of pictures. However, the interation of VHF $\times$ picture-type was significant ($F = 11.41$; d.f. $= 1, 14$; p. $= .004$) as can be seen clearly from Figure 1. Follow-up analyses exploring this interaction revealed significantly better performance on the realistic pictures in the LVF than in the RVF ($F = 10.80$; d.f. $= 1, 14$; $p = .005$). Moreover, as in the positive responses, there was a significant difference between surrealistic and realistic pictures within the RVF, with higher scores for the former than for the latter ($F = 16.21$; d.f. $= 1, 14$; $p = .001$), but not within the LVF.

RT Data

Positive responses. RT's in the RVF were significantly faster than in the LVF ($F = 6.32$; d.f. $= 1, 14$; $p = .02$) and surrealistic pictures were recognized significantly faster than realistic ones ($F = 5.35$; d.f. $= 1, 14$; p. $= .03$). The VHF $\times$ picture-type interaction was found to be significant and most likely reflects the different hemipsheric strategies used by the subjects in processing these pictures ($F = 5.52$; d.f. $= 1, 14$; $p = .03$). The nature of this interaction was explored further with tests for simple effects. The outcome was quite similar to that obtained with the accuracy data as follows. The mean response time for surrealistic pictures was faster in the RVF than in the LVF ($F = 18.81$; d.f. $= 1, 14$; $p = .007$) while there was no signifcant difference between the two VHF's on the realistic pictures. The difference in mean response time between the surrealistic and realistic pictures within the RVF was significant ($F = 9.83$; d.f. $= 1, 14$; $p = .007$) but the difference between these two variables was not significant within the LVF. All of this can be seen clearly in Figure 2.

Negative responses. The ANOVA revelaed main effect for the factor of VHF ($F = 12.39$; d.f. $= 1, 14$; $p = .003$) reflecting faster responses in the RVF than in the LVF. A main effect for the factor of picture-type ($F = 5.55$; d.f. $= 1,14$; $p = .003$) reflects the fact that surrealistic pictures were recognized faster than realistic pictures. No significant interaction emerged for these two factors.

Summary and Discussion

The first and most significant finding of this experiment is that surrealistic pictures were remembered better in the left than in the right hemisphere. This is supported by both the accuracy and response time data. The left hemisphere advantage receives additional significance in view of the second important finding, namely, that within the left hemisphere there was a dissociation between processing surrealistic and realistic pictures with surrealistic pictures being remembered better than realistic ones. This, too, is supported by both the accuracy and the RT data.

At the same time, we obtained no strong evidence for better memory for realistic pictures in the right hemisphere. However, we did find evidence for a certain specialization in this category of picture-type: There was a LVF over RVF superiority in choosing realistic decoys while there was no significant difference between the two VHF's in choosing the surrealistic decoys. Furthermore, there was no clear-cut evidence for hemispheric asymmetry for correct rejections. Taken together, then, the present results give support to the notion of hemispheric specialization in processing paintings showing objects of the real world in markedly different ways.

EXPERIMENT 2

Given that we have determined that one type of picture could be remembered better in one hemisphere than in the other, we continued our investigation by exploring some relationships between art and language. Here, we tested memory for the metaphoric versus the literal titles. We considered that since the right hemisphere is severely limited in the area of language, the results on that side would reflect the combined effects of the linguistic disadvantage in reading quickly flashed material and the actual ability of processing the association between the titles and the pictures. Teasing these factors apart is difficult given the present experimental conditions. Thus, in reporting the results we focus on the left hemisphere, though right hemisphere results are reported as well.

Materials and Method

Subjects

Twenty-five different right-handed undergraduate students (12 females, 13 males) from the same pool of subjects elected to participate in the experiment.

Apparatus

The identical experimental set-up was used.

Stimuli

The pictorials stimuli were the same as in the previous experiment except that only the first 16 pictures (8 surrealistic and 8 realistic) were used. In the Appendix, those correspond to the first 8 pictures in the realistic category and the first 8 in the surrealistic catetory. In addition, 8 metaphoric and 8 literal titles were prepared. All were 2-word long. They consisted of either nouns or a noun and a adjective, counterbalanced within each type of linguistic meaning. A metaphoric phrase was defined as one made of ordinary elements combined to form an uncommon phrase, the meaning of which is different from the ordinary combination of the literal meaning of its elements (See Appendix). (For a review and discussion of the issue of incongruity in metaphors, see Kittay, 1987). The title for each picture was typed, photographed, and mounted on 2×2 slides. For the decoys there were 16 2-word titles, half metaphoric and half literal. In Experiment 2, only the word-titles were used as decoys whereas in Experiments 3, only the pictures were used.

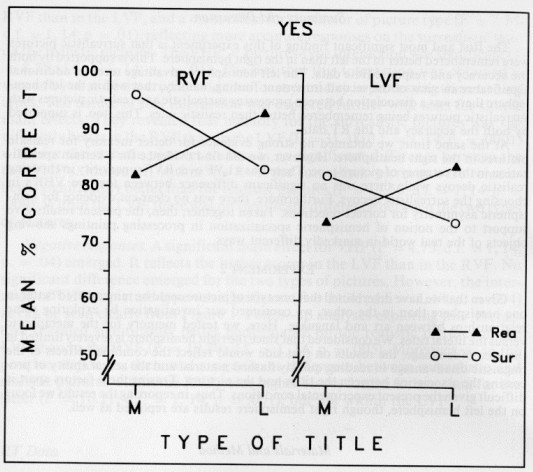

Fig. 3 – *Experiment 2. Mean percent correct for positive responses. RVF = right visual half-field; LVF = left visual half-field; M = metaphoric titles; L = literal titles.*

Design

Different (second order "congruous" or "incongruous") paired-associates were constructed as follows: Surrealistic-methaphoric (S-M), realistic-metaphoric (R-M), surrealistic-literal (S-L), and realistic-literal (R-L). Assignment of titles was counterbalanced with respect to the appropriate picture-type. Thus, in each VHF there were 2 each of the following pairs: S-M, R-M, S-L, and R-L.

Procedures

The identical experimental procedures were used again except for the addition of titles as follows: The 16 pairs of pictures and their respective titles were projected centrally for a duration of 4 sec each (there were 32 separate items in the study-list). The different pairs, i.e., S-M, S-L, R-M, and R-L, were intermixed within the study-list. During the study phase, the title preceded the picture. Subjects were instructed to remember both the pictures and their titles. Subsequently, the probes – the titles – were flashed laterally for an exposure duration of 170 msec.

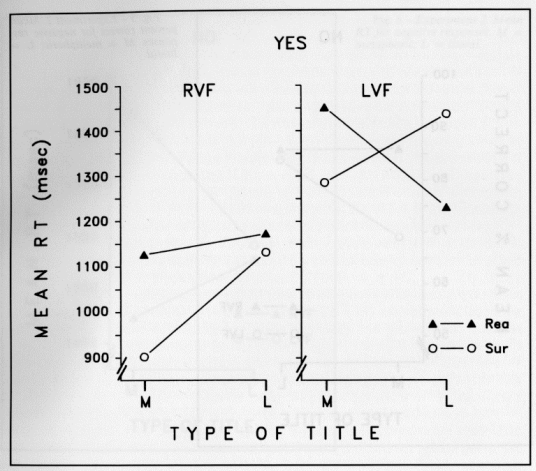

Fig. 4 – *Experiment 2. Mean RT for positive responses. RVF = right visual half-field; LVF = left visual half-field; M = metaphoric; L = literal.*

Results

The data are summarized in Figures 3, 4, 5, and 6. Only correct responses were analyzed, and, in the absence of significant differences between the hands or sexes, the data were collapsed across all subjects. In light of considerations outlined in the introduction to this experiment the focus was on dependent measures in the RVF. Thus, although an overall ANOVA was applied to the data, responses in each VHF were analyzed with separate ANOVA's as well. Within each VHF, the ANOVA for the positive responses tested the factors of picture-type (surrealistic, realistic), and of title-type (metaphoric, literal) while in the ANOVA for the negative responses the factor of picture-type was irrelevant. With the overall ANOVA, the factor of VHF (LVF, RVF) was added.

Accuracy Data

Positive responses (Figure 3) (1) Overall ANOVA. The main effect for VHF

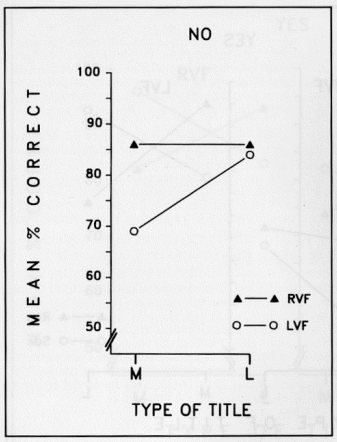

Fig. 5 – *Experiment 2. Mean percent correct for negative responses. M = metaphoric; L = literal.*

was significant (F = 13.13; d.f. = 1, 24; p = .004). It reflects, not surprisingly, higher scores in the RVF than in the LVF. There were no significant main effects for picture-type nor for title-type. The interecations of VHF × picture-type or VHF × title-type were not significant. However, the interaction of picture-type and title-type was significant (F = 14.46; d.f. = 1, 24; p = .0009). The triple interaction of VHF × picture-type × title-type was nonsignificant.

(2) Separate ANOVA's for each VHF. For the RVF, no significant main effects emerged but the interaction of picture-type × title-type was significant (F = 8.77; d.f. = 1, 24; p = .006). Post-hoc tests for simple effects revealed (1) that methaphoric titles paired with surrealistic pictures (S-M) were more accurately recognized than literal title paired with surrealistic pictures (S-L) (F = 5.20; d.f. = 1, 24; p = .03) or metaphoric title paired with realistic pictures (R-M) (F = 5.31; d.f. = 1, 24, p = .03). There was a statistically significant difference between the R-L and the S-L pictures.

For the LVF, no significant main effects were obtained. The interaction of picture-type × title-type was significant (F = 4.02; d.f. = 1, 24; p = .05). Analysis of simple effects revelaed no significant differences among the main factors.

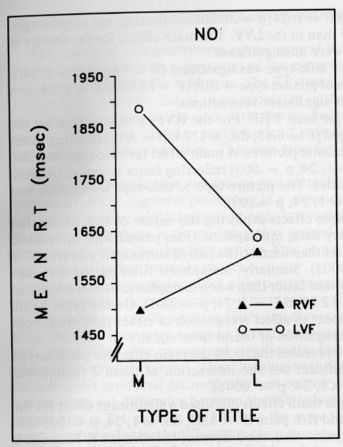

Fig. 6 – *Experiment 2. Mean RT for negative responses. M = metaphoric; L = literal.*

Negative responses (Figure 5) With the negative responses, the factor of picture-type was excluded since responses were merely to appropriate 2-word phrases, i.e, they were not titles which appeared in the to-be-remembered series.

(1) Overall ANOVA. The main effect for VHF was significant (F = 4.41; d.f. = 1, 24; p = .04) reflecting higher scores in the RVF than in the LVF. The main effect for title-type was also significant (F = 4.91; d.f. = 1, 24; p = .03) reflecting greater accuracy with literal phrases than with metaphoric phrases. The interaction of VHF × title-type approached significance (F = 3.86; d.f. = 1, 24; p = .06). There were no other main effects or interactions.

(2) Separate ANOVA's for each VHF. For the RVF, a significant main effect was not obtained for the factor of title-type while for the LVF, a significant main effect did emerge for title-type (F = 6.35; d.f. = 1, 24; p = .01) reflecting a better performance on the literal than on the metaphoric titles.

RT Data

Positive responses (Figure 4) (1) Overall ANOVA. A significant main effect for

VHF emerged ($F = 67.98$; d.f. $= 1, 24$; $p = .00001$) indicating, not surprisingly, faster responses in the RVF than in the LVF. The main effects for the factors of picture-type and title-type were nonsignificant.

The interaction of VHF $\times$ title-type was significant ($F = 4.90$; d.f. $= 1, 24$; $p = .03$) as was the interaction of picture-type $\times$ title ($F = 15.04$; d.f. $= 1, 24$; $p = .0007$). There were no other significant interactions.

(2) Separate ANOVA's for each VHF. For the RVF, a main effect for the factor of picture-type emerged ($F = 6.65$; d.f. $= 1, 24$; $p = .01$) reflecting faster RT to surrealistic than to realistic pictures. A main effect for title-type was also obtained ($F = 10.20$; d.f. $= 1, 24$; $p = .003$) reflecting faster response times to metaphoric than to literal titles. The picture-type $\times$ title-type interaction was significant ($F = 5.25$; d.f. $= 1, 24$; $p = .03$).

Post-hoc analyses of simple effects exploring the nature of this interaction revealed, as with the accuracy data, methaphoric titles paired with surrealistic pictures were recognized faster than literal titles paired surrealistic pictures ($F = 18.00$; d.f. $= 1, 24$; $p = .0003$). Similarly, metaphoric titles paired with surrealistic pictures were recognized faster than when metaphoric titles were paired with realistic pictures ($F = 12.74$; d.f. $= 1, 24$; $p = .001$). On the other hand, realistic pictures did not appear to affect recognition of either title. And, both types of pictures affected recognition of literal titles equally.

For the LVF, the analyses revealed that both the main effect for picture-type and title-type were nonsignificant but the interaction of these 2 factors was significant ($F = 9.75$; d.f. $= 1, 24$; $p = .0046$).

Post-hoc analysis of simple main effects disclosed a significant effect for the difference between the S-L and R-L pairs ($F = 4.85$; d.f. $= 1, 24$; $p = .03$) with RT being fastest for the R-L pairs. Also, the difference between the R-M and R-L pairs was significant ($F = 4.88$; d.f. $= 1, 24$; $p = .02$). However, the analysis revealed no significant difference between the S-M and S-L pairs or between the S-M and R-M pairs.

Negative responses (Figure 6) (1) Overall ANOVA. A significant VHF main effect emerged ($F = 61.39$; d.f. $= 1, 24$; $p = .0001$) indicating the faster response times in the RVF than in the LVF. The main effect for the factor of title-type was nonsignificant. The interaction of VHF $\times$ title-type approached significance ($F = 3.18$; d.f. $= 1, 24$; p. $= .08$).

(2) Separate ANOVA's for each VHF. For the RVF, a significant main effect for the factor of title-type emerged ($F = 5.65$; d.f. $= 1, 24$; $p = .02$) with faster responses to metaphoric than to literal titles.

For the LVF analysis, a significant main effect emerged for title-type ($F = 17.20$; d.f. $= 1, 24$; $p = .004$) reflecting the better performance on the literal than on the metaphor titles.

Interestingly, the difference between the VHF's was significant only on the metaphoric titles level ($F = 45.27$; d.f. $= 1, 24$; $p = .0001$) with the responses in the RVF being the fastest.

Summary and Discussion

The results of this experiment reveal several important findings. The data clearly indicate superior recognition of the metaphoric titles in the RVF. This was especially true for the S-M pairs. The RT data show this pattern most clearly (Figure 5). In contrast, literal titles appearing in the S-L pairs were recognized significantly less accurately and with diminished speed. On the other hand, neither type of title, literal or metaphoric, if paired with realistic pictures, was more effective than the other. This was true for both the RT and accuracy data.

These data suggest that metaphors and surrealistic pictures share some features which allow cognitive processing in a common semantic store or else that the two share retrieval strategies leading to improved memory. This is supported by the fact that there is no evidence that second-order incongruity results in improved memory in either hemisphere. That is, pair such as S-L or R-M did not contribute to higher memory scores.

In the LVF, metaphoric titles were not recognized significantly more accurately than literal titles, regardless of picture-type. The RT pattern nearly mimicks the accuracy results with the following exception: Literal titles were recognized fastest if they were assigned to realistic pictures during the study phase, and, literal titles were recognized significantly faster than metaphoric titles if assigned to realistic pictures. Thus, judging on the basis of the RT data, whereas the S-M pairs produced distinctly the best memory condition in the RVF, there was no clear-cut difference between the metaphoric titles in S-M pairs and the literal titles in R-L pairs in the LVF. At the same time, it may be worthwhile to point out that a distinctly different pattern emerged for the LVF: R-L pairs were recognized significantly faster than R-M or S-L pairs in the LVF.

Given the nature of linguistic processing by the right hemisphere, a tentative appraisal of the results of Experiment 2 may be offered, namely, that literal titles paired with realistic pictures, more than titles paired with surrealistic and more than metaphoric titles in any pairing, are processed better in the right hemisphere.

The pattern of negative responses, both in terms of accuracy and RT, reinforces the above assessment. That pattern shows significantly faster recognition of metaphoric decoys in the RVF than in the LVF and a trend in that direction in the accuracy scores. Since these correct negative responses were provided to stimuli which were in fact not present during the study phase, an argument could be made in support of left hemisphere specialization for methaphoric versus literal titles, per se, independently of paired association with pictures, surrealistic or realistic.

EXPERIMENT 3

In view of the fact that reading places certain constraints on the right hemisphere, it was important to continue to determine the effect of the titles on

memory for these pictures in that hemisphere. Thus, here we tested memory for the pictures themselves. That pictures can, under certain circumstances, tap knowledge structures in either hemisphere while words tap such structures better in the left than in the right hemisphere was demonstrated earlier by others (e.g. Levine, Banich and Koch-Weser, 1984; Levine and Banich, 1982).

Materials and Method

Subjects

Twenty-four different right-handed undergraduate students (14 females, 10 males) from the same pool of subjects elected to participate in the experiment.

Apparatus

The identical experimental set-up was used.

Stimuli

The picture and title stimuli were the same as in the previous experiment but this time the probes were pictures.

Procedures

The identical experimental procedures were used except that the probes, the pictures, were flashed laterally for an exposure duration of 100 msec.

Results

The RT and accuracy data are summarized separately in Figures 7, 8, 9 and 10. Only correct responses were analyzed. No appreciable sex or hand differences were noted and the data were collapsed across these variables. Separate ANOVA's were applied to the accuracy, and RT data. The repeated measures factors were for VHF (LVF, RVF), picture-type (surrealistic, realistic), and title-type (metaphoric, literal). With the negative responses, the factor of title-type was left out of the analysis since, as explained in the Experiment 2, it did not apply to the decoys.

Accuracy Data

Positive responses (Figure 7) A significant main effect for title-type emerged ($F = 9.47$; d.f. $= 1, 23$; $p = .005$) reflecting better memory for pictures paired with literal than with metaphoric titles. The main effect for the factor of picture-type was also significant ($F = 10.08$; d.f. $= 1, 23$; $p = .004$) reflecting better memory for the surrealistic than for the realistic pictures. The interaction of VHF $\times$ title-type was significant ($F = 7.01$; d.f. $= 1, 23$; $p = .01$). As before, we consider this statistical interaction reliable evidence for hemispheric asymmetry in processing the stimuli. Significantly, there was an absence of a main effect for VHF. This confirms our assumption that pictorial materials is better suited to probe hemispheric competence in both hemispheres. There were no other significant main effects or interactions.

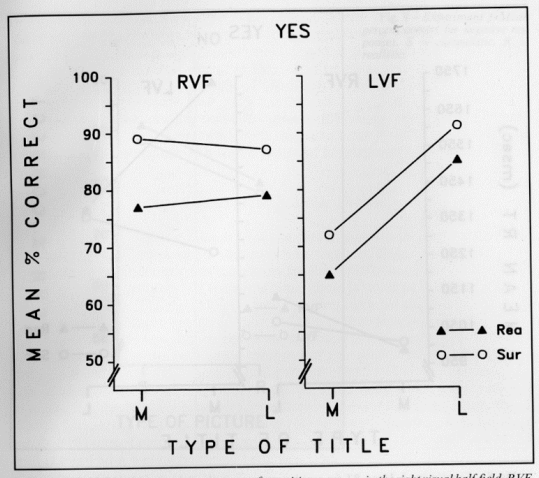

Fig. 7 – *Experiment 3. Mean percent correct for positive responses in the right visual half-field, RVF, and left visual half-field, LVF. M = metaphoric; L = literal; Rea = realistic; Sur = surrealistic.*

The nature of the statistical interaction was investigated further in post hoc analyses of simple effects. They revealed that while title-type was an important factor in the LVF, picture-type was important in the RVF. Specifically, within the LVF, both surrealistic pictures with literal titles ($F = 10.18$; d.f. $= 1, 23$; $p = .004$) and realistic pictures with literal titles ($F = 11.06$; d.f. $= 1, 23$; $p = .004$) were recognized faster than those paired with metaphoric titles. Within the RVF, surrealistic pictures were remembered better than realistic ones across titles ($F = 7.22$; d.f. $= 1, 23$; $p = .01$), but looking at the litle level, this difference was significant particularly on the level of metaphoric titles, with the surrealistic pictures benefitting the most from being assigned this title-type ($F = 5.31$; d.f. $= 1, 23$; $p = .03$). There was no significant difference on the level of the literal titles within the RVF. Moreover, RVF scores for the S-M pairs were significantly better than in the LVF ($F = 6.57$; d.f. $= 1, 14$; $p = .01$) while there was no significant difference between the two VHF's in remembering the R-M, S-L, or R-L pairs.

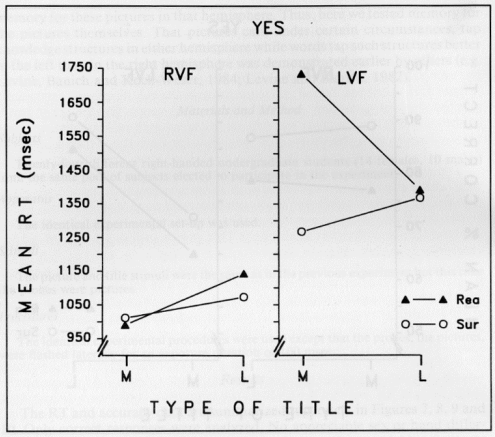

Fig. 8 – *Experiment 3. Mean RT for positive responses in the right visual half-field, RVF, and left visual half-field, LVF. Rea = realistic; Sur = surrealistic; M = metaphor; L = literal.*

Negative response (Figure 9) A main effect for picture-type was significant (F PU 0.26; d.f. = 1, 23; p = .006) reflecting better scores for the surrealistic than for the realistic pictures. There were no other main effects or interactions.

RT Data

Positive responses (Figure 8) Several main effects were obtained. The one for VHF was significant (F = 198.85; d.f. = 1, 23; p = .001) reflecting faster RT's in the RVF than in the LVF. Picture-type was significant (F = 11.05; d.f. = 1,23; p = .003) reflecting the fact that the surrealistic pictures were recognized faster than the realistic ones. The main effect for title-type was nonsignificant.

There were several interactions: The VHF × title-type (F = 7.31; d.f. = 1, 23; p = 01), VHF × picture-type (F = 11.77; d.f. = 1, 23; p = .0023), title-type × picture-type (F = 6.63; d.f. = 1, 23; p = .01), and VHF × title-type × picture-type (F = 15.61; d.f. = 1, 23; p = .0006) were all significant.

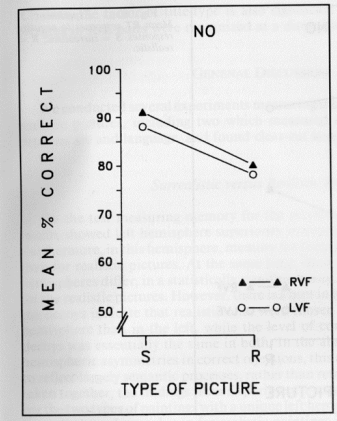

Fig. 9 – *Experiment 3. Mean percent correct for negative responses. S = surrealistic, R = realistic.*

The nature of these interactions was investigated through the use of post hoc tests for simple main effects and interactions. They revealed that, on the level of title-type, responses within the RVF were faster to the pictures with metaphoric titles than to those with literal titles (F = 3.97; d.f. = 1, 23; p = .05) whereas within the LVF responses were faster when the titles were literal (F = 3.58; d.f. = 1, 23; p = .05).

On the level of picture-type, mean RT was faster for surrealistic than for realistic pictures (F = 19.21; d.f. = 1, 23; p = .0002). Furthermore, within the LVF, surrealistic pictures in S-M pairs were recognized faster than realistic pictures in R-M pairs (F = 31.71; d.f. = 1, 14, p = .0001) and realistic pictures in R-L pairs were recognized than realistic pictures in R-M pairs (F = 13.71; d.f. = 1, 23; p = .0014).

Negative responses (Figure 10) Only the main effect for VHF was significant (F = 22.41; d.f. = 1, 23; p = .0001). It reflects the fact that RT's in the RVF were faster than in the LVF. There was no significant difference in mean response-time to surrealistic versus realistic pictures. The interaction of VHF × picture-type was significant (F = 5.53; d.f. = 1, 23; p = .02). Post hoc tests for simple

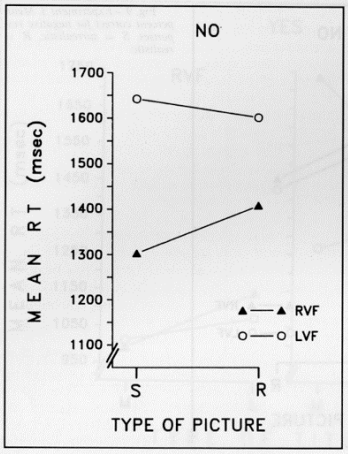

Fig. 10 – *Experiment 3. Mean RT responses to negative responses. S = surrealistic; R = realistic.*

effects showed that the nature of this interaction may be attributed to significantly faster RT's in the RVF than in the LVF on the level of surrealistic pictures but not on the level of the realistic pictures.

Summary and Discussion

The absence of a main effect for VHF suggests that picture probes tapped right hemisphere competence on a level that is comparable to that of the left hemisphere. The asymmetrical effects of pairing pictures and phrases in the two hemipsheres, then, should reflect specialization for the task at hand.

Comparing accuracy performance, scores were significantly higher for the surrealistic pictures in S-M pairs and realistic pictures in R-M pairs in the RVF than in the LVF. However, literal titles were not recognized better in the LVF than in the RVF. All of this is confirmed in the RT data.

Looking at the pattern of accuracy results in each VHF, in the RVF the main outcome was the superior memory for the surrealistic pictures, and, in particular, surrealistic pictures in S-M pairs were recognized significantly better than realistic pictures in R-M pairs. In contrasts, in the LVF, the salient result was the superior memory for pictures whose titles were literal. However, looking at the

RT data, the factor of title-type is also significant in the RVF, and realistic pictures in R-L pairs were recognized at a diminished speed in the LVF.

Genenal Discussion

We conducted several experiments measuring memory for surrealistic versus realistic pictures, including two which measured one kind of a relationship between art and language, and found clear-cut hemispheric asymmetries.

Surrealistic versus Realistic Pictures

On the test measuring memory for the pictures alone (Experiment 1), the results showed left hemisphere superiority in recognizing surrealistic pictures. Furthermore, in this hemisphere, memory for these pictures appears to be better than for realistic pictures. At the same time, their is no evidence that the two hemispheres differ, in a statistically significant way, in level of positive memory for the realistic pictures. However, there is a hint in that direction: The scores for the decoys indicate that realistic ones were chosen at a higher rate in the right hemisphere than in the left, while the level of correctly choosing surrealistic decoys was essentially the same in both. In the absence of strong evidence on hemispheric asymmetries in correct rejections, this outcome may be interpreted to reflect largely semantic processes, rather than retrieval strategies alone. Thus, taken together, the findings from Experiment 1 suggest asymmetries in processing the two types of paintings with a unique left hemisphere specialization for the surrealistic and a weak one for realistic paintings in the right.

The above conclusions regarding hemispheric asymmetries in processing artistic treatments of reality are consistent with findings by Grossman (1988) in a study of freehand drawings by non-artist patients with unilateral focal damage. He investigated their ability to draw objects upon being named (but not viewed). Qualitative analysis revealed that right brain damaged patients drew unusual, bizarre depictions of the objects (e.g., a potato growing on top of a stem) while the left group drew stereotypical depictions of objects. The interpretation offered here for his results is that the intact left hemisphere in the former group is mainly responsible for producing the unusual drawings while for the latter group, the intact right hemisphere is responsible.

Moreover, the results extend previous conclusions about the hemispheric nature of world-knowledge (e.g. Zaidel 1988, a) to the domain of art, namely, that in normal subjects memory for scenes that are incongruous with respect to known reality is better in the left than in the right hemisphere. And, we posit that not only does the use of different art styles as experimental tools illuminate the differences in the ways in which the two hemispheres process information about the world, but also that these differences, in turn, suggest aspects of the cognitive process in the brain of the artist himself and of persons observing art works.

In particular, how can the superior memory for surrealistic paintings be explained within the framework of cognitive theories of memory for distinctive-

ness? One possibility is based on increased attentional resources activated during the encoding stage of a picture is not schema-consistent with respect to knowledge-of-the-world (Hastie, 1981). This extra attention, in turn, is considered to lead to good retention because the use of increased attentional resources requires deep semantic processing, a level of cognitive activity supporting good retrieval (Eysenck and Eysenck, 1979). Conversely, applying the above to the present findings, we may speculate that left hemisphere cognitive processing would appear to be better suited than the right's for tasks requiring increased attentional resources, possibly because "deeper" level semantic processing is performed.

Pictures and Language

We have also obtained some understanding of the relationship between art works and their titles. When stimulus pictures were assigned metaphoric or literal titles, the surrealistic-metaphoric pairs were better remembered when presented to the left than to the right hemisphere. This was true regardless of whether the probes were words or pictures, and especially in the RT data. Our findings, then, strongly suggest that cognitive processes in the left hemisphere are such that they support specialized processing of features that surrealistic pictures and metaphors have in common.

That linguistic and pictorial semantics tap a common function was hinted at in non-artists in a study by Gainotti et al. (1983). Their report suggests a relationship between pictorial production and semantic aspects of language, although its nature was not investigated systematically. Aphasic patients suffering from semantic-lexical impairment drew significantly worse reproductions from memory of previously seen objects than aphasic patients not suffering from such an impairment.

The present findings do not support previously drawn conclusions about metaphors by Winner and Gardner (1977) or Brownell (1988). Their results or conclusions would have predicted that the intact right hemisphere would be better suited for processing pictorial depictions of metaphoric expressions than the intact left hemisphere. Our data instead point to left hemisphere superiority in processing pictorial depictions of metaphoric phrases, although our phrases were not commonly used idioms.

We did not obtain convincing evidence that realistic-literal pairs are better processed when presented to the right than to the left hemisphere. However, the evidence suggests that either surrealistic or realistic pictures with lateral titles are remembered significantly better than those with metaphoric titles in the right hemisphere. This particular pattern strongly suggests to us that the right hemisphere, thought not specialized for language functions, has storage/retrieval strategies which apply to common and simple literal phrases better then to new metaphoric ones. Hence, even if the right hemisphere plays some role in processing metaphors, our results suggest that it does not specialize in it.

What is the nature of the relationship between surrealistic paintings and metaphors? On the surface, what characterizes in the two is that common elements form arrays that consist of specific violations of standard rules of semantic combination, even if one is linguistic and the other pictorial. Thus, the fact that the two share anatomical and functional substrates in the brain, may not be surprising. Moreover, since those violations do not render the resulting arrays meaningless, it may be worthwhile to consider the possibility that "equilibrium points" between violation and meaningfulness are marks of creativity.

Art and Brain

It is natural to consider here the relationship between art style and cognition in the brain. As stated earlier, thus far, there has been remarkable paucity of data about hemispheric cognitive processing of genres and movements in the arts. The present results are important in making a preliminarly contribution to such an understanding. In particular, Experiments 2 and 3 suggest that understanding of surrealistic pictures may be obtained in terms of a "verbal art hypothesis" or of a "combinatorial art hypothesis". According to the former, metaphors are a purely linguistic phenomenon and surrealistic pictures tap the same linguistic processes used for understanding metaphors. According to the latter hypothesis, both metaphors and surrealistic pictures are not linguistic phenomena, and both involve a violation of standard rules of semantic combination and use similar strategies for processing such arrays.

Left Hemisphere Functions

How can we extend the commonly accepted notions of cognitive processes in the left hemisphere in light of the present results? The fact that metaphoric recognition and surrealistic picture recognition were found to be highly correlated in the RVF suggests a specialization in processing related types of "incongruity" with respect to world-knowledge. That is, the left hemisphere may have special interpretation methods applied correctively to extraordinary, apparently incongruous entities consisting of common elements. The methods is corrective in the sense that it is applied only in case other, frequently used, strategies fail.

Applying known characterizations of left hemisphere functional specialization, in rule-governed tinking strategies and in language, how can can the present view be accommodated? By way of speculation, two complementary interpretations are offered. (1) Logical, rule-governed thinking: One may argue that in a cognitive system that specializes in rule-governed thinking, there is one type of schema that processes established knowledge, and another type of schema which specializes in new interpretations of data by allowing cognitive processes which "transcend" the known features of the world and promote understanding that may be characterized as "creative" (Zaidel, 1987). It may have evolved in order to complement, by may of "compensation" for the precision required in logical, rule-governed analysis. (On discussions of the creative aspect of metaphors see, Black, 1979; Mac Cormac, 1985; and Kittay, 1987). (2) Language: Linguistic processing strategies show significant flexibility with respect to violations of the

rules of language since often expressions we produce and undertsand are linguistically incorrect, e.g., words are sometimes repeated or omitted when they have to be uttered exactly once. But in most cases such violations do not appear to impede understanding. Hence, it is reasonable to assume that the very process of language understanding consists of accomodation to deviations from rules.

Metaphors

Both philosophers of language and linguists have suggested various theories of metaphoric expressions, but none has been accepted as providing an adequate explanation (Ortony, 1979). It has recently been claimed that they should not be explained within a framework of a theory of meaning for linguistic expressions (Davidson, 1984; Cooper, 1986). This claim leaves open the following posibilities: (1) That metaphors may be viewed in terms of another component of language, e.g. Pragmatics, or (2) that they are not understood within any component of a general theory of language. The present results strongly suggest that the second alternative be considered a major source of explanation. Thus, we could look at metaphors as manifesting a special case of a more general cognitive phenomenon, viz. the ability to ascribe meanings to special arrays which violate basic rules of combination.

Conclusions

Our results suggest the following points: First, art genre (or style) is neurologically multi-faceted, involving distinct hemispheric processes. Second, the recognition of surrealistic paintings appears to engage selectively the observer's left hemisphere. Moreover, this is no mere "coincidence". Rather, memory for this type of painting appears to be related, in a way yet to be shown empirically, to language functions. Third, the distinction between surrealistic and realistic paintings, so far couched in psychoanalytic, aesthetic, and social explanations, can now be given anatomical and functional explanations in terms of characteristic storage/retrieval strategies in the left hemisphere. Fourth, the present results suggest that metaphors are, in a certain sense, not a specifically linguistic phenomena, but rather the linguistic case of a general cognitive phenomenon.

Abstract

The issue of hemispheric processing of art works, either alone or in relation to a certain aspect of language, was investigated in normal subjects. Three experiments were performed. In the first, memory for surrealistic versus realistic pictures was investigated. In the second, memory for metaphoric versus literal titles of these pictures was measured. In the third, memory for the paintings was determined as a function of the same titles. The results of the first experiment showed a right visual field (RVF) advantage for the surrealistic pictures. No field difference emerged for the realistic pictures. The results of the second experiment indicated a RVF advantage in memory for metaphoric titles. Moreover, in the RVF, there was an advantage for titles from surrealistic-metaphoric pairs over all other pairings. Results of experiment three showed a RVF advantage in remembering pictures from surrealistic-metaphoric pairs and, in the left visual field (LVF) there was advantage for pictures with literal titles. Taken together, the results suggest left hemisphere advantage in processing meaningful, yet incongruous arrays, both pictorial and linguistic. The results are discussed in terms of hemispheric memory for art works, metaphors, and the relationship between the two in the brain.

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Appendix 1

A list of the stimuli and their artists used in the study-list.

Artist	Title
Surrealistic	
1. Magritte, R.	"The Therapeutist"
2. Magritte, R.	"Treasure Island"
3. Magritte, R.	"The Idea"
4. Magritte, R.	"The Rape"
5. Magritte, R.	"Collective Invention"
6. Labisse, F.	"Medusine"
7. Khnopff, F.	"The Caress"
8. Gallardo, G.	untitled-Barcelona exhibition
9. Gallardo, G.	art for an advertisement
10. Gallardo, G.	art for "The Killing of Sister George"
11. Magritte, R.	"The Oasis"
12. Magritte, R.	"The Red Model II"
Realistic	
13. Renoir, P.	"The Ball at Bougival"
14. Abbott, L.F.	"Horatio Nelson"
15. Redon, O.	"Vase of Flowers"
16. Burne-Jones, E.	"Love Leading the Pilgrim"
17. Bernard, E.	"Portrait of Madelein Bernard"
18. Rouault, G.	"The Meal"
19. Delveaux, P.	"All the Lamps"
20. Delveaux, P.	"The Shadows"
21. Bingham, G.	"Fur Traders Descending the Missouri"
22. anonymous	"The Hobby Horse"
23. Gallardo, G.	art for an advertisement
24. Sloan, J.	"Sunday, Women Drying Their Hair"

Appendix 2

A list of the metaphoric and literal phrases used in Experiments 2 and 3 is provided below:

Title	Picture
Metaphoric	
Apple head	"The Idea"
Airy plants	"Treasure Island"
Sea Feet	"Collective Invention"
Moody doves	Gallardo-unknown title
Vague love	"Love Leading the Pilgrim"
Color junction	"Vase of Flowers"
Live stencil	"Horatio Nelson"
Shadow wife	"The Shadows"
Literal	
New rape	"The Rape"
Hand caress	"The Caress"
Weak philosopher	"The Therapeutist"
Flood medusa	"Medusine"
Late meal	"The Meal"
Street lamps	"All the Lamps"
Common ball	"The Ball at Bougival"
Woman face	"Portrait of Madelein Bernard"

Appendix 3

Sources for stimulus paintings.

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