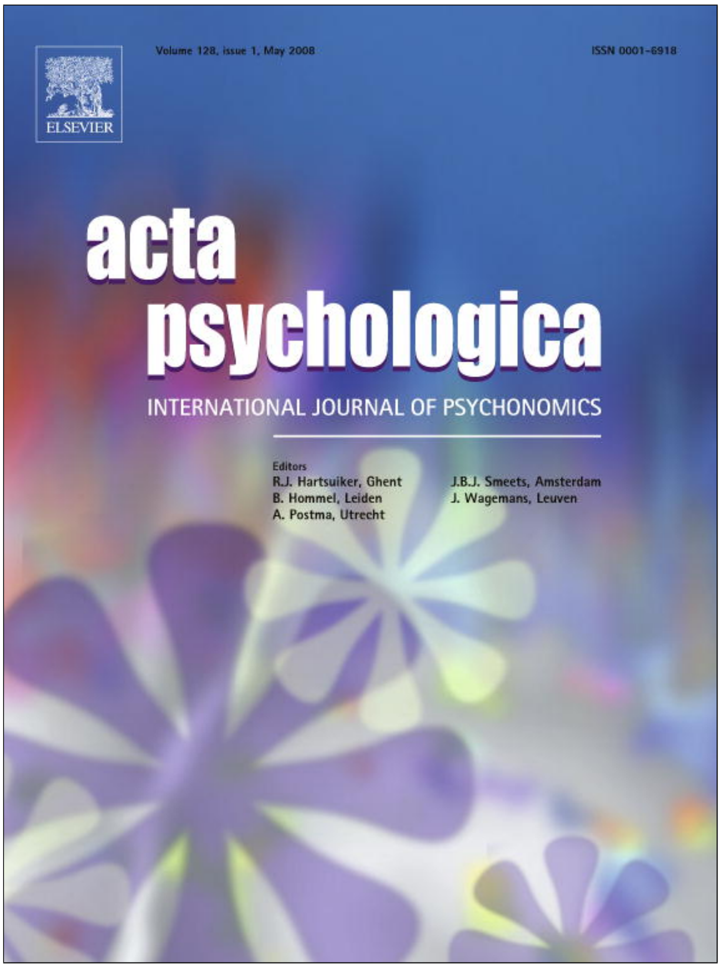
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Style follows content: On the microgenesis of art perception

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Abstract

Despite fruitful research in experimental aesthetics, the dynamics of aesthetics, i.e., the processes involved in art perception, have received little attention. Concerning representational art, two aspects seem most important in this respect: style and content. In two experiments, we examined the dynamics of processing of style and content by means of the microgenetic approach. This approach systematically varies perceptual conditions to find out about the stages involved in the formation of percepts – their microgenesis. Participants gave similarity ratings for pairs of pictures that were fully crossed in style (artist) and content (motif). Presentation times were systematically varied between 10, 50, 202 and 3000 ms (Experiment 1) plus unlimited presentation time (Experiment 2). While effects of content were present at all presentation times, effects of style were traceable from 50 ms onwards. The results show clear differences in the microgenesis of style and content, suggesting that in art perception style follows content.

PsycINFO classification: 2323; 2340; 2610

Keywords: Microgenesis; Art perception; Style; Content; Style-related processing

1. Introduction

What happens when we look at a work of art? This question has fascinated experimental psychologists since the beginnings of their science as an institutionalised field of research, starting with Fechner's *Vorschule der Ästhetik* in the 19th century (Fechner, 1876). Since then, numerous findings have been reported concerning the question which characteristics might influence aesthetic judgments and art perception in general (Berlyne, 1974; Cutting, 2003; Kreitler & Kreitler, 1972; Kunst-Wilson & Zajonc, 1980), but the question how and when these characteristics may play a role during the perception of an artwork has received less attention. Precisely: What are the processes involved in art perception?

When it comes to the question of underlying processes of perception and the interactions among them, the *microgenetic* approach has proven a useful tool. According to this approach, percepts are the outcome of a complex interplay and succession of several perceptual sub-processes (Flavell & Draguns, 1957). The logic of the microgenetic approach is to gradually vary perceptual conditions, such as contrast or presentation time, to investigate the *microgenesis* of a certain percept, i.e., how this percept evolves in real time (Bachmann & Vipper, 1983). This provides the opportunity to get a deeper understanding of the perceptual and cognitive processes involved. As Bachmann (2000, p. XI) puts it: "...one of the best ways to understand the nature and the future potential of whatever particular object of theoretical interest there is consists in tracing back and analysing its origins and developmental changes it has undergone." Bachmann assumes a "continuum of...perceptual states" (2000, p. 2). We interpret this continuum not in a strictly linear way, but as an interaction of bottom–up and top–down phenomena in terms of a *time*

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course contingency suggested by Sanocki (1993). According to this view, information acquired early in processing may constrain or modify later processing, thus making the perceptual process more efficient.

Research on the microgenesis or, more generally, the time course of perception, has been conducted in the realm of object perception (Eddy, Schmid, & Holcomb, 2006; Grill-Spector & Kanwisher, 2005; Kent & Lamberts, 2006; VanRullen & Thorpe, 2001b), face perception (Carbon & Leder, 2005; Sergent, 1989), facial impression formation (Bar, Neta, & Linz, 2006), perceptual organisation and grouping (Kimchi, Hadad, Behrmann, & Palmer, 2005; Schulz & Sanocki, 2003), and perception of real-world scenes (Bacon-Macé, Macé, Fabre-Thorpe, & Thorpe, 2005; Fei-Fei, Iyer, Koch, & Perona, 2007).

So far, only few studies have related the idea of microgenesis to art perception, focussing on the temporal development of emotional aspects (Smith, Sandström, Sjöbeck, & Sjögren, 1969), the role of titles for aesthetic processing (Leder, Carbon, & Ripsas, 2006), or the development of arousal-related properties (Bachmann & Vipper, 1983; Cupchik & Berlyne, 1979). The latter studies provide evidence that the perception of artworks proceeds from complex and disorderly to simple and orderly (Bachmann & Vipper, 1983; Cupchik & Berlyne, 1979), which is in line with the idea of a stabilisation of the percept over time (Bachmann, 2000). Bachmann and Vipper (1983) introduced another line of research on the microgenesis of art perception by systematically employing stimuli from different schools of art. They found that participants were able to differentiate between different schools of art even when presentation times were limited to 1 ms, with the most extreme differences found between realism and abstractionism. Yet, it is worth analysing the term schools of art further: From a visual point of view, schools of art differ not only in the way motifs are depicted, i.e., style, but also in the general choice of motifs, i.e., content. In this respect, realism and abstractionism represent two extreme points on a continuum, with the former trying to depict objects in a realistic way and the latter deliberately refraining from the depiction of real-world objects. Yet, the close interrelation of content and style holds also true for other schools of art. As the processing of content is presumably related to general processes of object perception, while style is a special characteristic of art and design, it seems psychologically essential to separate style and content by means of systematic variation.

Both style and content have been proposed to be central variables in the processing of representational art (Leder, Belke, Oeberst, & Augustin, 2004). Content has been shown to be of central importance with respect to the classification (Augustin & Leder, 2006) and appreciation of art, especially for persons without background in the arts (Hekkert & vanWieringen, 1996). Style, on the other hand, is a feature that is art-specific (Leder et al., 2004) and might thus be considered a central aspect that differentiates art perception from other forms of perception. According to the model of aesthetic appreciation and aesthetic judgments by Leder et al. (2004), style and content become most relevant during *explicit classification* of artworks, after more basic aspects such as contrast, colours and familiarity have already been processed. Yet, style may also be relevant at earlier processing stages, as is suggested by research on implicit learning (Gordon & Holyoak, 1983). To our knowledge, no study so far has empirically examined the temporal aspects of style- and content-related processing and the relation of both sub-processes during the perception of art. The present study attempts to bridge this gap, aiming to further decipher the microgenesis of art perception.

Given the fact that the perception of objects is highly relevant in everyday life and has been assumed to rely on automatic, feed-forward mechanisms (VanRullen & Thorpe, 2001a), the processing of content can be expected to onset earlier than the processing of style. Although there is evidence that information on a featural level becomes relevant to perception before the recognition of objects (Fei-Fei et al., 2007), style furthermore constitutes a complex combination of different such featural aspects. Consequently, there is no direct evidence for the exact onset of the processing of style. Findings from the realm of object and scene perception provide an informative basis concerning the time course of perception of content in art. Research suggests that people perceive and recognise objects at astonishing speed, with categorisation on basic level needing no more information or processing time than detection of the mere presence of an object (Grill-Spector & Kanwisher, 2005). EEG studies have shown processing times of about 150 ms to be necessary for object categorisation (Thorpe, Fize, & Marlot, 1996; VanRullen & Thorpe, 2001b). However, regarding the stimulus information required for the classification of objects in scenes, masked presentations of 27 ms may already be sufficient for above-chance performance, even under dual task conditions (Li, VanRullen, Koch, & Perona, 2002).

For the systematic investigation of style- and content-related processing, the present study realised an orthogonal combination of the factors *style* and *content* by employing materials that were fully crossed with respect to both artist and motif. In accordance with the microgenetic approach, presentation times were systematically varied. To allow the examination of the processing of style irrespective of an individual's expertise, participants were asked to judge the similarity of pairs of these pictures, since similarity judgments do not require familiarity with art-specific vocabulary. It has been shown that similarity judgments may be influenced by a wide range of associations besides simple feature comparisons (Maderthaner & Kirchler, 1981/1982). Still, we asked for unspecified similarity rather than defining which aspects to concentrate on, because we were interested in the relevance of style and content at different points of processing.

2. Experiment 1

Experiment 1 aimed to examine the relevance of style and content for participants' similarity ratings of paintings at different presentation times, i.e., 10, 50, 202, and 3000 ms. Ten ms was chosen as a lower limit, lying below the presentation times that have mostly been reported as being sufficient for above-chance object classification (e.g., Grill-Spector, Kushnir, Hendler, & Malach, 2000; Li et al., 2002). According to results reported by Fei-Fei et al. (2007), different levels of object perception become more pronounced than featural information at around 40–67 ms. Thus, a presentation time of 50 ms was expected to tap into an interval of high relevance for object perception. Similarly, we regarded a presentation time of about 200 ms (The choice of exactly 202 ms instead of 200 ms in Experiment 1b was due to the refresh rate of the monitor, see below) a perceptually relevant time-frame in terms of a boundary between pre- and post-saccadic processing, since evidence from eye-movement research (Rayner, 1998) suggests that saccade latency ranges at least between 150 and 175 ms. Finally, a presentation time of 3000 ms was intended to clearly allow higher order processes to come into play.

Experiment 1 comprised two sub-experiments, 1a and 1b, each contrasting two levels of presentation time (*PT*). The samples of 1a and 1b were equated by means of paired matching, thus allowing within-subjects analyses (Bortz, 2005; Gliner & Morgan, 2000). Age- and sex matched persons were assigned the same pseudo-randomisation and, in all but four cases in which participants had to be excluded (see below), saw the stimuli in the same randomised order. Across matched pairs randomisation order was varied. The data of each matched pair were treated as within-subjects data (Bortz, 2005; Gliner & Morgan, 2000). The reason for dividing presentation times between two sub-experiments rather than combining them in one single experiment was to reduce carry-over effects between different *PT*s that had been found in pre-studies combining more presentation times.

In the following, the methods of Experiments 1a and 1b are described separately, followed by the combined analyses of both sub-experiments.

2.1. Method

2.1.1. Method Experiment 1a

Experiment 1a examined the processing of style and content at 10 and 50 ms.

2.1.1.1. Participants. Twenty-six students of the University of Vienna participated for course credit or on voluntary basis. Two participants were excluded from analysis because they reported prior education in the arts or art history. The remaining sample consisted of 4 men and 20 women aged 18–33 years ($M = 21.9$, SD $= 3.3$). All of them had normal or corrected to normal vision. None of the participants had received any formal training in art or art history beyond regular school education.

2.1.1.2. Materials. The materials consisted of 48 reproductions of paintings or sections of paintings (see Appendix) that represented four contents and four styles, i.e., four motifs painted by four artists. The paintings had been scanned from art books or taken from the internet. In both cases only high quality reproductions were accepted. We selected the final set of pictures on the basis of a pre-study from an original sample of 107 exemplars. The four motifs (i.e., contents) were tree/trees, flowers, house, and male person, the four artists (i.e., styles) Paul Cézanne, Marc Chagall, Ernst-Ludwig Kirchner, and Vincent Van Gogh. The reason for deciding upon these motifs and artists was that each of the four levels of style and each of the four levels of content had to be distinct compared to the other levels but homogeneous in itself, while simultaneously a satisfactory number of good exemplars of each category had to be available for stimulus choice. Style was operationalised in terms of *individual style* (Wölfflin, 1979) to optimise homogeneity within cells. We only chose artists from the late 19th and early 20th century instead of covering a broader range of art history to avoid a confound of style-related information by content due to fashion of clothing (male persons) or architecture (houses). The content level *male person* comprised half length and full length portraits but no nudes.

In cases where the motif of interest was not in central focus of the painting, the object was cut out and the respective section of the artwork was used. Painters' signatures as well as any meaningful writing or symbols were removed.[1]

In a pre-study, ten students classified the original sample of 107 pictures according to their content and style and gave ratings of confidence (content) or typicality (style) of both classifications. The point of reference was the four category names in the case of content and, in the case of style, four typical paintings of each painter that had been presented during a learning phase. Moreover, we asked for judgments of familiarity (yes/no) for each painting. Pictures with more than 30% familiarity judgments were excluded from stimulus choice. For every combination of motif and artist we then chose those three exemplars with the highest percent correct classification of both style and content. Choices between pictures with the same values were conducted on random basis.

The 48 selected pictures were brought to the size of 140,000 square pixels at 72 dpi, while maintaining each

[1] We are aware of the fact that these manipulations modify the pictures not only in terms of originality, but also in terms of the stimuli's role as art, and that by using sections spatial aspects of style, such as balance (Locher, Gray, & Nodine, 1996), get lost. Yet, we favoured strict experimental control of content over originality and furthermore aimed to avoid any external hints to the painter. We were predominantly interested in style in terms of brushstroke, treatment of lines, or colours, and these aspects should not have been severely impaired by the manipulations.

picture's format dimensions. Picture width ranged from 9.15 cm to 14.91 cm, picture height from 9.60 cm to 15.68 cm. The pictures were combined via pseudo-randomisation to form 192 pairs of pictures. Forty-eight of these pairs represented each of the 2 (*style*) × 2 (*content*) conditions *same style–same content* (SStyle–SContent), *same style–other content* (SStyle–OContent), *other style–same content* (OStyle–SContent) or *other style–other content* (OStyle–OContent), respectively. Each picture appeared twice in each condition, while each combination of the levels of *style* and *content* appeared once. For example, in the condition SStyle–OContent, each Cézanne tree was randomly combined with one Cézanne house, one Cézanne flower and one Cézanne male person.

For each pair, the position of the pictures on the screen, left and right, was randomly assigned. The pseudo-randomisation procedure was conducted twice, resulting in two groups of 192 pairs of pictures, pseudo-randomisations A and B.

2.1.1.3. Procedure. The experiment was controlled by the experimental software Psyscope 1.25 PPC (Cohen, Macwhinney, Flatt, & Provost, 1993) and ran on a G3 Power Mac with an external 17-inch CRT screen, at a 1024 × 768 resolution with a 100 Hz refresh rate. Viewing distance was approximately 65 cm. Visual angles ranged from 22.5° to 27.0° in the horizontal and 8.5 to 13.8° in the vertical axis. All instructions were given in German. One half of the participants were assigned to pseudo-randomisation A, the other half to B.

The experimental trials were preceded by ten practice trials which were identical to the main trials but involved different stimuli, i.e., representational paintings by Maurice de Vlaminck, Paula Modersohn-Becker, and Robert and Sonia Delaunay.

Each trial started with a 150 ms fixation cross, followed by a 150 ms blank screen. Then the stimulus pair appeared for 10 or 50 ms, respectively, followed by an 80 ms blank screen and a black and white random dot pattern mask lasting for 200 ms. We used a delayed masking procedure to minimise visual artifacts that might be caused by direct interaction of stimuli and mask (Eriksen, 1980).

For each pair of paintings, participants rated the similarity of both paintings. Ratings were to be given on a scale from one to seven by means of the numeric buttons on the keyboard, 1 corresponding to *very dissimilar* and 7 to *very similar*. Participants were explicitly encouraged to define for themselves what similar or dissimilar meant. The question ("How similar are the two pictures?") and the scale appeared together with the stimulus pair and stayed on the screen until the persons had given their judgments, irrespective of the presentation time of the pictures. Ratings as well as response times, measured from the onset of pictures until button press, were recorded by the experimental program.

Each stimulus pair appeared twice, once for 10 ms and once for 50 ms, resulting in 384 trials that were run in six cycles of 64 trials. The cycles were separated by self-paced breaks. Across all cycles, both the order of the stimuli and the order of *PT*s were randomised.

Post-experimentally, the participants rated all 48 pictures for familiarity on a scale from 0 to 7, 0 corresponding to *not at all*, 1 to *a little*, and 7 corresponding to *very well*. To find out about their level of explicit recognition of style, the participants were furthermore asked to sort printouts of all 48 pictures into four groups representing four artists. Last, the participants filled in a short questionnaire concerning their interest in art and education in art or art history.

2.1.2. Method Experiment 1b

Experiment 1b examined the processing of style and content at 202 and 3000 ms.

2.1.2.1. Participants. Twenty-seven students of the University of Vienna participated for course credit. Three of them had to be excluded from analysis, because of education in the arts or art history (1 case), response bias, i.e., choice of the same key in more than 50% of responses (1 case), or because mean and standard deviation of response times lay significantly above average (1 case). The remaining sample consisted of 4 male and 20 female students aged 19–36 years ($M = 21.9$, $SD = 3.7$). None of them had participated in Experiment 1a and none of them reported any formal education in art or art history beyond regular school education. All participants had normal or corrected to normal vision.

2.1.2.2. Materials. Materials were the same as in Experiment 1a.

2.1.2.3. Procedure. The experiment was conducted on an Apple eMac with an integrated 17-in. CRT screen, at a 1024 × 768 resolution, with an 89 Hz refresh rate. The procedure was the same as in Experiment 1a except for the fact that presentation times were 202 and 3000 ms, respectively.

2.2. Results

The results section concentrates on the results of the similarity task. Analyses of the participants' ratings of familiarity with the paintings revealed low familiarity ($M = 0.783$, $SD = 0.433$), cross-validating the selection of stimuli as described above. Familiarity was thus excluded from further analyses. In the style-sorting task, 78% of the groups that the participants formed were clearly dominated by one artist. We defined dominance as a proportion of at least 50% of pictures by one artist (baseline 25%). These groups were most homogeneous in the case of Van Gogh (75% Van Gogh), followed by Cézanne (69% Cézanne), Kirchner (68% Kirchner) and Chagall (67% Chagall).

Response times were used for outlier exclusion of similarity data. Outliers were extracted according to a two-step algorithm: After excluding all responses with RTs of 15 s or more, we excluded all those of the remaining data that fell out of the range of ±3.0 SDs around the individual mean RT. For all subsequent analyses only data meeting these criteria were used.

Inter-rater reliability of similarity ratings, calculated by intra-class correlations for each presentation time, lay between 0.904 and 0.952, indicating high inter-rater agreement. For all following analyses, the pairwise matched data of Experiments 1a and 1b were combined and analysed by means of within-subjects analyses (Bortz, 2005; Gliner & Morgan, 2000). Similarity ratings ($M = 3.658$, $SD = 1.339$) showed high variation between the 2×2 conditions of *style* and *content* at the four presentation times. Fig. 1 shows the means and standard errors of the mean of similarity ratings for the four combinations of *style* and *content* at all four presentation times (*PT*s).

To test for time-related differences in the effects of style and content, we conducted a 2 (*same style* vs. *other style*) × 2 (*same content* vs. *other content*) × 4 (*PT*) repeated measures analysis of variance (see Table 1 for an overview of the results of the ANOVA).

It yielded significant main effects of *style*, *content*, and *PT*. Same style was generally given higher ratings than other style ($M_{SStyle} = 3.843$, $M_{OStyle} = 3.473$) and same content received higher ratings than other content ($M_{SContent} = 4.653$, $M_{OContent} = 2.663$). The main effects of *style* and *content* were qualified by a significant *style* × *content* interaction. Further analyses by simple main effects (see Table 1) revealed significant effects of *style* on both levels of *content*, yet with greater effect size on the same content level. Time-related effects of style and content were evident in significant *style* × *PT* and *content* × *PT* interactions as well as a significant three-way *style* × *content* × *PT* interaction. Simple main effects of *content* were significant on all four levels of *PT*, while the effects of *style* were significant at 50 ms, 202 ms, and 3000 ms, but not at 10 ms. Effect sizes of the content effect showed relatively little variation except for a small peak at 50 ms, while the effect sizes of the style effect increased steadily over presentation times.

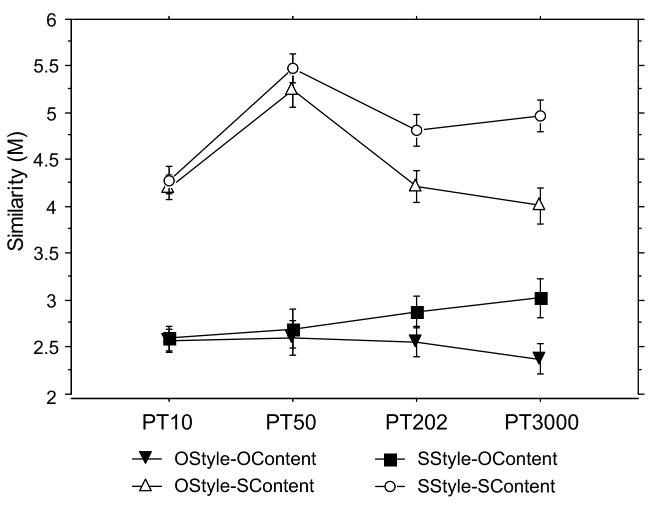

Fig. 1. Means and standard errors of the means of similarity ratings (*y*-axis) at all four levels of *PT* (*x*-axis) in Experiment 1, split by the 2 × 2 conditions of *style* and *content*.

Table 1
ANOVA table for the 2 (*style*) × 2 (*content*) × 4 (*PT*) within-subjects ANOVA on similarity ratings from Experiment 1

Effect	*df*	*F*	*p*	η^2_p
Main effects				
style	1/23	130.8	<0.001	0.850
content	1/23	344.0	<0.001	0.937
PT	3/69	5.2	0.003	0.183
Interactions				
style × *content*	1/23	24.8	<0.001	0.519
style × *PT*	3/69	41.7	<0.001	0.644
content × *PT*	3/69	9.6	<0.001	0.295
style × *content* × *PT*	3/69	2.9	0.040	0.112
Simple main effects				
$style_{OContent}$	1/23	48.1	<0.001	0.677
$style_{SContent}$	1/23	166.0	<0.001	0.878
$content_{OStyle}$	1/23	298.4	<0.001	0.928
$content_{SStyle}$	1/23	369.7	<0.001	0.941
$style_{PT10}$	1/23	1.8	n.s.	0.074
$style_{PT50}$	1/23	12.0	0.002	0.342
$style_{PT202}$	1/23	90.2	<0.001	0.797
$style_{PT3000}$	1/23	100.2	<0.001	0.813
$content_{PT10}$	1/23	156.9	<0.001	0.872
$content_{PT50}$	1/23	203.8	<0.001	0.899
$content_{PT202}$	1/23	100.9	<0.001	0.814
$content_{PT3000}$	1/23	95.8	<0.001	0.806

2.3. Discussion

We examined the time course of the processing of style and content in art over a time span ranging from 10 to 50 ms (Experiment 1a) and 202 to 3000 ms (Experiment 1 b), employing a method of pairwise similarity ratings.

The high inter-rater reliabilities of the data suggest that the dependent variable similarity, despite its seemingly subjective character, is capable of assessing general psychological phenomena. In judging similarity, the participants referred to both content and style, as indicated by the significant main effects of both factors. The interaction between *style* and *content* may be explained by the fact that it is easier to judge similarities regarding style, if content is held constant (see Cupchik, Winston, & Herz, 1992).

Most importantly, however, the effects of *style* and *content* as well as their interaction were clearly time-related, suggesting differences in the differential microgenesis of content- and style-related processing. As expected, effects of content could be observed earlier than effects of style, being already present at 10 ms, while simple main effects of *style* could be traced from 50 ms onwards.

These results extend the findings presented by Bachmann and Vipper (1983), who, to our knowledge, were the first to systematically investigate the role of different art schools for the microgenesis of art. In their study, participants differentiated between different schools of art from 1 ms onwards. Here we show that it is essential to further analyse effects of art schools in terms of style and content, since processing of these two aspects can be separated not only according to its onset, but also according to its development over time. Inspection of the development of effect sizes of both effects over all four presentation times suggests that the effect of style increased steadily over time, while the effect of content had already reached its size at 10 ms – with one exception, i.e., a relative peak at 50 ms. There may be two explanations for this result: First, despite the paired matching procedure, differences between the two samples cannot totally be ruled out. Second, seen as a contrast effect, the relatively large effect size of the content effect at 50 ms might be an indicator of a general change in processing from more sensory-related to more object-related, as proposed by Fei-Fei et al. (2007). Yet, one has to be careful with any interpretation, since the differences in effect size between 50 ms and the other *PT*s are rather small.

Another aspect has to be addressed concerning the time-related effects of style: Even though the processing of style seems to follow the processing of content, the participants differentiated not only between different contents but also between different styles on the basis of pre-saccadic information (i.e., in the *PT* range of <200 ms). This result is most remarkable considering the fact that our participants were untrained in the arts. One way of explaining these unexpected abilities may lie in the dependent measure used, since judgments of similarity do not require explicit classification of styles and may therefore rely upon information like colours or contrast that are processed at earlier stages (Marr, 1982).

Experiment 1 supports the notion that in art perception the processing of content starts earlier than the processing of style. However, the results do not allow one to draw more general conclusions concerning the time course of style- and content-related processing, which go beyond the specific presentation times used. To address this issue we conducted Experiment 2, which employed unlimited presentation times to assess baseline ratings for all pairs of pictures. By correlating these with the data of Experiment 1, we were able to derive a measure of the progress of processing at each presentation time. This measure was to provide information about how the course of processing of style and content could generally be described and how quickly the processing of the four combinations of *style* and *content* would be saturated, i.e., how quickly the state of unlimited presentation time would be reached.

3. Experiment 2

Experiment 2 assessed baseline ratings for all pairs of pictures used in Experiment 1. To derive a measure of the progress of processing at the different points in time these were correlated with the similarity data of Experiment 1. The aim was to generalise from data assessed at discrete presentation times to get an idea of the general time-related development of style- and content-related processing. For this purpose, we looked for a plausible exponential function that could model the correlations between each *PT* and baseline and would thereby yield general curves characterising the development of processing. The modelling was done separately for all four combinations of *style* and *content*.

3.1. Method

3.1.1. Participants

Participants were 24 students of the University of Vienna (11 men) aged 19–27 years ($M = 21.5$, $SD = 2.2$), who received course credit. All participants had normal or corrected to normal vision. None of them had participated in Experiment 1.

3.1.2. Materials

The stimulus material was the same as in Experiment 1.

3.1.3. Procedure

The experiment was controlled by Psyscope 1.25 PPC (Cohen et al., 1993) and ran on an eMac with an integrated 17-in. CRT screen, at a 1024 × 768 resolution with an 89 Hz refresh rate. Viewing distance was approximately 65 cm. Half of the participants saw the picture-pairs of pseudo-randomisation A, the other half saw those of B. Each participant was presented with a different random order of stimuli.

For each pair of pictures the participants gave ratings of similarity on a scale from one to seven, 1 corresponding to *very dissimilar* and 7 to *very similar*. Like in Experiment 1, the participants were explicitly encouraged to use their own definition of similar and dissimilar. All instructions were given in German. Presentation times were unlimited, i.e., the stimuli stayed on the screen until the participants gave their ratings.

The experimental program recorded both ratings and response times, measured from the onset of pictures until button press.

3.2. Results

An analysis of inter-rater reliability of similarity ratings yielded an intra-class correlation of 0.937, thus revealing high inter-rater reliability. To analyse the baseline data concerning general effects of style and content as well as interactive effects, we conducted a 2 (*style*) × 2 (*content*) repeated measures ANOVA on the mean similarity ratings of Experiment 2 (see Table 2).

Like in Experiment 1, the ANOVA yielded highly significant main effects of *style*, $F(1,23) = 107.5$, $p < 0.001$, $\eta_p^2 = 0.824$, and *content*, $F(1,23) = 186.9$, $p < 0.001$, $\eta_p^2 = 0.890$, which were qualified by a significant interaction *style* × *content*, $F = 42.1$, $p < 0.001$, $\eta_p^2 = 0.646$. Tests of

Table 2
Experiment 2: means and standard deviations of response times for all four combinations of *style* and *content*

Stimulus type	Similarity	RT
OStyle–OContent	2.260 (0.664)	2885.7 (987.4)
OStyle–SContent	4.056 (0.916)	3102.9 (1269.3)
SStyle–OContent	2.721 (0.692)	3004.2 (1082.1)
SStyle–SContent	5.041 (0.786)	3148.3 (1203.1)

Table 3
Parameter values and coefficients of determination of the exponential rise-to-max functions for the four combinations of *style* and *content*

Stimulus type	*a*	*b*	R^2
OStyle–OContent	0.758	0.117	0.939
OStyle–SContent	0.770	0.010	0.980
SStyle–OContent	0.761	0.065	0.927
SStyle–SContent	0.847	0.020	0.998

simple main effects revealed the effect of *style* to be significant on both levels of *content*, yet with greater effect size in the case of same content (F_{OContent} (1,23) = 41.8, $p_{\text{OContent}} < 0.001$, $\eta^2_{\text{p OContent}} = 0.645$; F_{SContent} (1,23) = 122.7, $p_{\text{SContent}} < 0.001$, $\eta^2_{\text{p SContent}} = 0.842$).

The following analyses aimed at modelling the general development of processing of style and content. To obtain a measure of progress of processing for each combination of *style* and *content*, we calculated a mean similarity score for each item at each presentation time of Experiment 1 and for the baseline data of Experiment 2. These were the basis for the correlations between the data of each presentation time and the baseline: For all four combinations of *style* and *content*, the data of each *PT* of Experiment 1 were correlated with the baseline data of Experiment 2. Fig. 2 shows the resulting correlations.

The correlational data were fitted to exponential rise-to-max functions. For all four combinations of *style* and *content*, the correlations between the four levels of *PT* and baseline could be modelled by an exponential function of the general form $y = a * (r_{\max} - \exp(-b * x))$, with $r_{\max} = 1.0$. This specific function was used as it allows the fixation of a converging maximum correlation ($r_{\max} = 1.0$) and estimation of the correlational max (parameter *a*) and curvature (parameter *b*). The estimations of parameters are summarised in Table 3.

As can be seen in Fig. 2, the functions for other content generally showed a steeper rise than those for same content. To test whether this might reflect a general tendency for slower processing in the case of same content we also drew upon the response time data of Experiment 2. A 2 (*style*) × 2 (*content*) repeated measures analysis of variance with response time as dependent variable (see Table 2) yielded a trend towards a main effect of *content*, $F(1,23) = 3.7$, $p = 0.067$, n.s., $\eta^2_p = 0.139$, with the mean response time for same content ($M = 3125.6$ ms) being higher than that for other content ($M = 2944.9$ ms).

3.3. Discussion

By combining the data of Experiment 1 with the baseline data of Experiment 2, our findings can be extended to a general course of development of style- and content-related processing. The correlational analysis of the data from

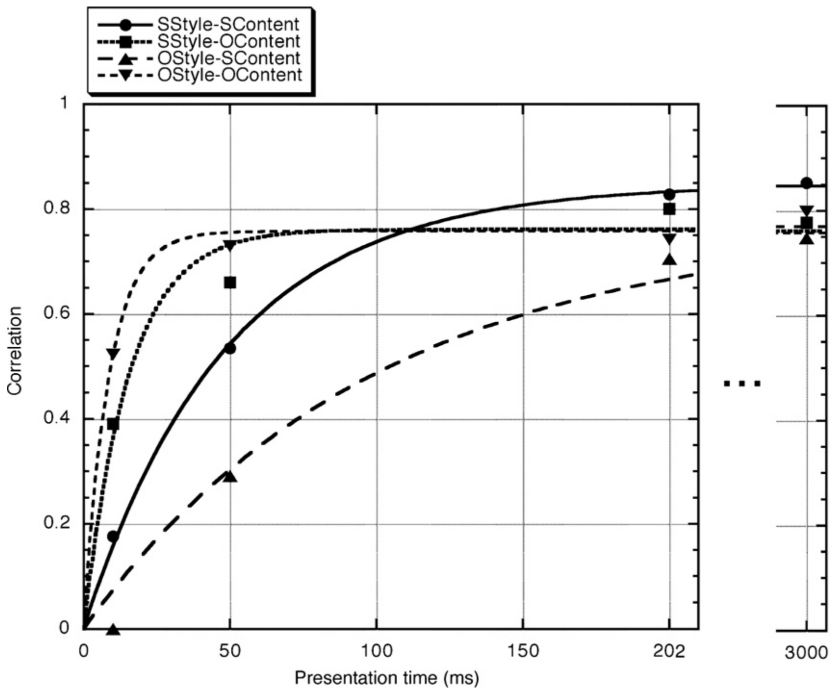

Fig. 2. Correlations of similarity ratings at all four presentation times of Experiment 1 with baseline ratings of Experiment 2, split by the 2 × 2 conditions of *style* and *content*. Lines represent the exponential rise-to-max functions to which the correlational data were fitted.

Experiments 1 and 2 shows that the microgenesis of style- and content-related processing can be modelled by means of exponential rise-to-max functions that differ in theoretical max and curvature. Generally, we would expect the asymptote of all four functions to be $r \rightarrow 1.0$, since with increasing presentation time processing should approach the level of unlimited presentation time. The fact that the asymptote was characterised by approximately $r = .85$ may be due to the differences between the samples of Experiments 1 and 2 or to the simple fact that specific processing of some art-relevant characteristics will never fully be saturated over time.

Fig. 2 indicates that the functions for pairs of other content generally show a steeper rise than the functions for pairs of same content. Due to higher curvature, the other content functions furthermore approach their asymptote earlier than the same content functions, suggesting earlier saturation of the related processes. Moreover, the results of the ANOVA on the similarity ratings from Experiment 2 support the findings of Experiment 1. Not only did the participants refer to both content and style, but also both aspects were obviously processed interactively. Taken together, these findings suggest certain conclusions concerning the general relation of style- and content-related processing: If two pictures differ in content, they are quickly perceived as dissimilar, and additional processing time (in our case more than 50 ms) only results in marginal changes of this impression. In contrast, if two pictures depict the same contents, processing proceeds more slowly – presumably because in this case style becomes a relevant criterion of similarity (see also Cupchik et al., 1992). In the case of same content, impressions of similarity steadily change over time and clearly diverge between same and other style. As a test of these assumptions we analysed the response times for the baseline ratings of Experiment 2, following the idea that response times partly reflect processing times, even though these are confounded with time needed for motor reaction. There was a trend towards longer response times in the case of same content, but effects failed significance. Thus, the process model outlined above will have to be further tested in future studies.

4. General discussion

In two experiments, we examined the perception of style and content as two central aspects of representational painting from a microgenetic point of view. By using materials crossed in style and content and by varying presentation times, we aimed at finding out how style- and content-related processing develop temporally and how the two sub-processes interact. The dependent variable employed was judgments of similarity.

Our results suggest that in art perception the processing of style develops later than the processing of content. While effects of content on similarity ratings were present at all presentation times, effects of style could first be traced after 50 ms.

These findings are in line with the results reported by Locher, Krupinski, Mello-Thoms, and Nodine (2007), according to which the processing of an art stimulus begins with a gist reaction that is followed by scrutiny of pictorial features. With a view to evolutional theory and the functions of perception a sequence of style following content obviously makes sense: Humans need to distinguish quickly and efficiently between different objects to succeed in their environment, while the discrimination of artistic style is a rather specialised ability that is relevant only in special situations. This does not preclude that style may convey some aspects of evolutionary relevance, such as tension or dynamics, some of which have already been shown to be differentiated at shortest presentation times (Bachmann & Vipper, 1983).

Yet, from our point of view, another important view on style has to be discussed: If style is not approached with a reference to art historical significance or underlying concepts (and this was not explicitly encouraged in our study), it is predominantly characterised by a combination of visual or sensory features including colours, brushwork, and treatment of lines. According to theories of object perception (e.g., Marr, 1982), processing of basic visual features precedes object recognition. From this view, the finding of style following content seems astonishing. It may be interpreted as a further indicator that art perception constitutes a special case that differs from "everyday" perception in more than just its object of interest (Leder et al., 2004): Whereas in everyday perception basic visual features are crucial to identify objects themselves, artists deliberately use such features to alienate, to emphasise, to create a certain expression – and this is what viewers identify as a style.

Obviously, our participants regarded style as a relevant aspect of similarity at presentation times as short as 50 ms – even though they were not explicitly instructed to concentrate on stylistic features. This finding challenges the common view on the relation between expertise and art perception. People without expertise in art or art history have been shown to be able to explicitly judge stylistic similarity of paintings (Cupchik et al., 1992) and to be sensitive to style across different media (Hasenfus, Martindale, & Birnbaum, 1983) and to perturbations of a painting's compositional structure (Locher, 2003), but asked to explicitly categorise paintings or to sort artworks into a meaningful order, non-experts have been reported to use feelings or content rather than style (Augustin & Leder, 2006; Cupchik & Gebotys, 1988). In our study, the participants used both content and style as relevant criteria for similarity and differentiated between same and different styles starting from presentation times as short as 50 ms. This provides evidence that non-experts do extract stylistic features on the basis of pre-saccadic information, and even more than that: Not only were the participants successful at judging on the basis of both content and style, but they obviously regarded both aspects as relevant determinants of similarity at early stages of processing. The key to explaining this result may lie in the dependent measure used. When giving judgments of similarity participants are neither required to have knowledge of art-specific vocabulary, nor do they have to give reasons for their categorisations or judgments (as in Augustin & Leder, 2006) or to decide upon one single criterion (as in Cupchik & Gebotys, 1988). Furthermore, they do not need to explicitly recognise that two pictures are of same or different style, but might as well base their judgment on singular features, such as colour or contrast. The method presented here may therefore generally provide a useful tool to analyse processing of complex stimuli independently of explicit knowledge.

Besides the more general findings about the onset of style- and content-related processing, our findings provide evidence concerning the relation of both sub-processes. In Experiment 1, the development of the effect sizes of both effects over time suggests that a presentation time of only 10 ms seems to be sufficient for participants to extract information about similarity of content, and additional presentation time does not result in a general change of the relevance of content. Style, in contrast, steadily gains in relevance with increasing presentation time; the longer the time of exposure, the more stylistic information is extracted and drawn upon for judgment. In addition, the results of both experiments indicate that style is more relevant if content is kept constant, which is in line with the findings presented by Cupchik et al. (1992) indicating interactive processing of both dimensions. Taken together with the results of the combined analysis of Experiments 1 and 2, i.e., the functions of the development of processing for all four combinations of *style* and *content*, these results might imply the following dynamics of processing: People concentrate on content from the very beginning of the presentation of a painting, being certain about judging the content-related similarity of two paintings on the basis of very early information. Especially if content is similar, style comes into play as a further relevant criterion of similarity. Thus, processing seems to be saturated relatively early in the case of other content, while in the case of same content additional presentation time results in the gathering of information about style and a continuous change of similarity ratings.

Some aspects have to be kept in mind when considering the interpretations presented above: First, it is important to note that unless the results found here are replicated with other materials, they will have to be interpreted on the basis of the stimulus material used, i.e., the four levels of style and content employed in the study. It is difficult to quantify the amount of similarity of style and content or to even try to equalise these two levels. One may yet think of materials in which the style manipulation is extreme compared to the content manipulation, e.g. male and female portraits painted by cubist and impressionist artists. By employing the paradigm used here to such a material, future studies will have to test whether the microgenetic relations reported above can be regarded a general principle in art perception.

The question just discussed is intrinsically tied to the role of expertise. One of the reasons why it is difficult to equalise the similarity of style and content is that this relation presumably depends on the viewer's art-related education and knowledge. As discussed above, research in empirical aesthetics (Augustin & Leder, 2006; Cupchik & Gebotys, 1988; Hekkert & vanWieringen, 1996) as well as the model of aesthetic appreciation and aesthetic judgments by Leder et al. (2004) suggests that the relevance of style for classifying and evaluating art may increase with expertise. It is thus reasonable to assume that art-related expertise may also change the temporal aspects of the processing of style and content. As a consequence, future studies should systematically examine the microgenesis of style and content for different levels of expertise.

Furthermore, one has to allow for the possibility that the early effects of style and content reported above might partly be due to differences in low-level features, such as colour or amplitude-and phase information. A similar discussion has been led with respect to the field of scene identification (Delorme, Rousselet, Macé, & Fabre-Thorpe, 2004; Gale & Laws, 2006; Torralba & Oliva, 2003), while the actual importance of single features for object detection and recognition is still under dispute (see, e.g., Delorme, Richard, & Fabre-Thorpe, 2000; Goffaux et al., 2005; Nijboer, van der Smagt, van Zandvoort, & de Haan, 2007). On the basis of the present data, the question of the role of low-level cues for early effects of style and content cannot be solved, but as a consequence the presentation times discussed above should be interpreted as approximate values. Other studies from the realm of microgenesis have shown that estimates of required presentation times or of processing times differ widely depending on the method used (compare, e.g., Grill-Spector et al., 2000; Li et al., 2002). One critical point in this respect may concern the method of masking, the effect of which can differ depending on parameters such as mask type (Bachmann, Luiga, & Poder, 2005) or energy level (Francis & Herzog, 2004). Yet, irrespective of the masking procedure used and irrespective of the exact time values we propose that the general development of style- and content-related processing outlined above can be assumed to remain the same.

Finally, we want to point to the fact that encounters with artworks in non-experimental settings are usually extended in time and may last much longer even than the self-paced viewing times found in Experiment 2. It is reasonable to assume that the process of art perception is subject to changes also during such longer encounters with artworks. For example, results reported by Leder et al. (2006) show that the interaction of artwork and title changes between presentation times of 1 s, 10 s, and 90 s. In the study presented here, we primarily concentrated on microgenesis as defined by Flavell and Draguns (1957, p. 197), as "prestages of extremely brief cognitive acts". However, especially with respect to style-related processing it may be a valuable approach to conduct research employing longer presentation times to further disclose the microgenesis of art perception.

To sum up, we found evidence of a differential microgenesis of two central aspects of the perception of representational art, style and content. While content-based information could be efficiently extracted from a presentation time of 10 ms onwards and its processing seemed to be saturated at about 202 ms, style-based processing was downstreamed with an onset of a *PT* of 50 ms, gaining in relevance throughout the timespan of 50–3000 ms.

Thus, we propose that in the microgenesis of art perception style follows content. If we consider style the characteristic of art, this characteristic needs some time to unfold – but still, it unfolds quicker than you may think.

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Appendix. List of paintings used in Experiments 1 and 2

Artist	Motif	Title	Year
Cézanne, Paul (1839–1906)	Tree/trees	Grand pin et terres rouges (section)	ca. 1895
		Le grand Pin	1887–1889
		Marronniers et Ferme du Jas de Bouffan (section)	1885–1887
	Flowers	Bouquet de Fleurs dans un Vase bleu (section)	1873–1875
		Nature morte, fleurs et fruits (section)	1888–1890
		Fleurs dans un Pot D'Olives (section)	ca. 1880
	House	La Maison Lézardée (section)	1892–1894
		Maison devant la Sainte-Victoire, prés de Gardanne (section)	1886–1990
		La Maison Maria (section)	ca. 1895
	Male person	Portrait d'Ambroise Vollard (section)	1899
		Le paysan	ca. 1891
		Portrait de paysan assis (section)	1898–1900
Chagall, Marc (1887–1985)	Tree/trees	Derrière la maison (section)	1917
		Le poète aux oiseaux (section)	1911
		La Leçon de Philétas (section) Lithographie	1957–1961
	Flowers	Intérieur aux fleurs (section)	1917
		Bella a Mourillon (section)	1926
		Le magicien (section)	1968
	House	La Pluie (section)	1911
		La maison brûle ou La calèche volante (section)	1913
		Vitebsk (section)	1917
	Male person	Le poète Mazin (section)	1911–1912
		Le juif en vert (section)	1914
		Le juif rouge (section)	1914
Kirchner, Ernst Ludwig (1880–1938)	Tree/trees	Tiergarten, Berlin	1912
		Bergwald (section)	1918/1920
		Gut Staberhof, Fehmarn I (section)	1913
	Flowers	Stilleben mit chinesischem Porzellan (section)	1920/1938
		Alpenveilchen (section)	1918
		Der Maler, Selbstportrait (section)	1919–1920
	House	Pfortensteg Chemnitz (verso) (section)	1910
		Nollendorfplatz (section)	1912
		Straßenbahn und Eisenbahn (section)	1914
	Male person	Otto Mueller mit Pfeife (section)	1913
		Selbstbildnis	1914
		Der Maler, Selbstportrait (section)	1919–1920

Appendix (*continued*)

Artist	Motif	Title	Year
Van Gogh, Vincent (1853–1890)	Tree/trees	La Récoltes des olives (section)	1889
		Parc à Arles (section)	1888
		Pêcher en fleurs (section)	1888
	Flowers	Vase avec iris (section)	1890
		Nature morte: vase avec lauriers-roses et livres (section)	1888
		Vase avec lilas, marguerites et anemones (section)	1887
	House	Chaumières à Cordeville (section)	1890
		Le vieux Moulin (section)	1888
		La Maison jaune (La Maison de Vincent) (section)	1888
	Male person	Portrait d'Alexandre Reid	1887
		Portrait de l'écrivain belge Eugène Boch	1888
		Portrait d'un jeune paysan (section)	1889

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