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Morphing Systems: Analysing the Influence of Different Parameters on the Perception of Morphing

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ABSTRACT

This paper presents an online survey investigating how different parameters influence the perception of morphing in gestalt changes. Eleven animations were created in Blender to analyse the effects of three key parameters - subgestalt, animation curve, and duration - on the morphing effect. In the online survey, completed by n = 104 participants, the animations were evaluated regarding if they are perceived as morphing and the extent to which they fulfilled the defining characteristics of morphing. The results indicate that morphing represents an effect within a gestalt change, which can be enhanced, diminished, or disrupted depending on these parameters. When all morphing characteristics are met, even single subgestalt changes can be perceived as morphing; however, changes in layout and shape elicit a stronger morphing impression than changes in colour or graphic. Additionally, the distribution of the change over the duration strongly affects perception: evenly distributed changes are perceived as the smoothest, whereas transformations with high change intensity at the beginning appear faster.

Keywords: Morphing, Gestalt changes, Influences on changes, Changing effect, Subgestalt changes

INTRODUCTION

Gestalt-changing products allow customers to tailor a product to their needs or enable to adapt to them. While the initial and target states of such changes are often clear, the type of change and how it is perceived remain less defined but crucial (Rasmussen et al., 2012).

Morphing is a specific type of gestalt change, defined as a transformation which is perceived as a smooth change over time (Rommel et al., 2025). The defined characteristics allow morphing to be distinguished from other types of gestalt changes. However, these characteristics have different parameters with a wide variety. The central question, therefore, is how these parameters must be set for a change to be perceived as morphing and how they influence the perception of the gestalt change.

This paper presents an online survey examining how parameters such as subgestalt changes, duration and the animation curves affect the perception of a gestalt change. Particular attention is given into morphing, exploring whether it should be seen as a spectrum in which certain parameters amplify or diminish the morphing effect.

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State of the Art

One key parameter under consideration are the subgestalts of an object. According to Seeger (2005) and Holder et al. (2019), the gestalt of an object can be divided into four subgestalts: layout, shape, colour/surface and graphics.

The layout refers to the arrangement and proportions of the basic bodies an object is made of (Seeger, 2005; Holder et al., 2019). For example, in Figure 1, the cup consists of a small cylinder for the handle and a large cylinder for the cup body.

The shape is the sum of all uncoloured forms of the unlabelled gestalt. This includes all lines and the surface transitions (Seeger, 2005; Holder et al., 2019). In Figure 1 the cup's layout remains consistent, but the basic bodies adopt more conical and curved shapes.

Colour and surface describe all texture elements given to the unlabeled gestalt (Holder et al., 2019). These include hue, saturation, brightness and surface texture. In Figure 1, the cup is shown in bright blue colour with a glossy finish.

Graphics cover applied graphical elements such as symbols and letters (Seeger, 2005; Holder et al., 2019). In Figure 1, for instance, the cup bears a coffee bean symbol.

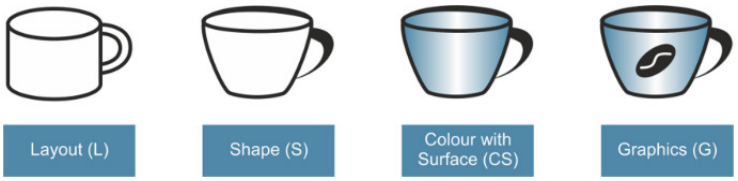


Figure 1: Subgestalts layout, shape, colour and surface and graphics (Holder, 2019).

Based on this definition, a gestalt change occurs whenever one of the subgestalts change (Rommel et al., 2025). This raises the question of how changes in individual subgestalts influence the perception of morphing compared to changes to the entire gestalt.

Rommel et al. (2025) define five key characteristics of morphing.

1. A change in one or more subgestalts,
2. An integrative gestalt for the initial and target states, (Bürdek, 2015)
3. A change occurring over time,
4. Perceivability of the change and
5. A smooth transition (achieved through sufficient intermediate states with integrative gestalts).

These characteristics are illustrated in Figure 2, which contrasts morphing with a discrete change. In a discrete change, the transition from initial to target state is instantaneous. In a morphing change, by contrast, the initial and target states are experienced as a unified whole, changing smoothly and continuously over time. Whereas a discrete change appears as a leap, morphing is perceived as a gradual, perceivable transformation (Rommel et al., 2025).

While these characteristics define morphing, they also involve a wide range of parameters to be investigated. For instance, although a change in a single subgestalt constitutes as a gestalt change, it remains unclear how its impact on the morphing effect compares to changes in other subgestalts or whether such differences exist at all. Similarly, the required timeframe for a gestalt change to be perceived as morphing is undefined.

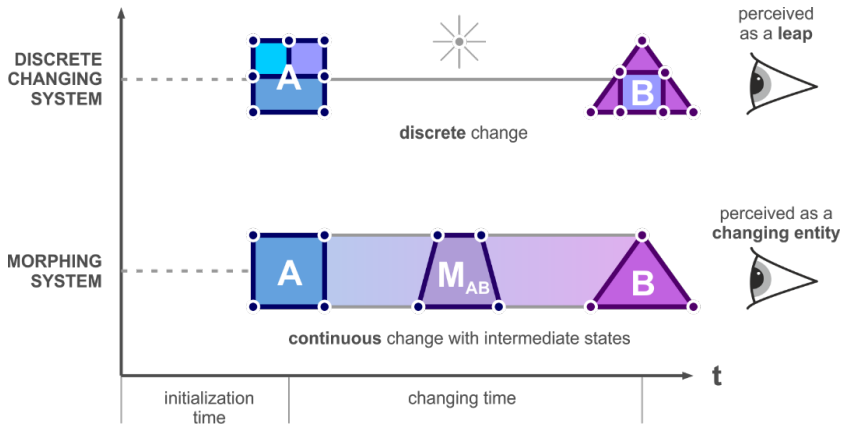


Figure 2: Comparison morphing to a discrete change (Rommel et al., 2025).

Another important aspect is the role of the animation curve. Even when changes occur within the same overall timeframe, different distributions of change can lead to different perceptual effects. It is therefore necessary to compare the perception of the morphing effect of a standard linear transition to other non-linear transition curves.

Methodical Approach

To investigate these parameters, eleven different gestalt changes were animated using Blender (Blender, 2025). In most cases, simple basic bodies were used to minimize the number of changing elements to ensure that the attention was focused on the parameter under study rather than multiple simultaneous elements changing.

The animations include a morphing change, in which all subgestalt change, four animations in which only one subgestalt changes and one with a discrete change. The morphing animation, with every subgestalt changing, and the discrete change are used as references to draw conclusions about the other animations and to validate the morphing definition and characteristics proposed by Rommel et al. (2025). By comparing the single subgestalt changes to these reference cases, the influence of the individual subgestalts on the perception of morphing can be analysed.

In addition, one animation combined morphing and discrete changes by showing a morphing layout and shape change in combination with a discrete colour and graphics change. This setup was designed to investigate whether a mixture of change types disrupts the perception of morphing. Another animation maintained a constant volume throughout the transformation, as real

products conserve volume when their layout changes. This allows for an analysis of whether a constant volume influences the perceived morphing effect. To approximate a more realistic product scenario, an additional animation depicting a cyan teacup with a tea-bag graphic morphing into a cappuccino cup with a coffee-bean graphic, is added. The graphical transformation was implemented with the help of a Reeb diagramm (Kanonchayos et al., 2002).

Two further animations examined the effects of duration and animation curve on the perception of morphing. In both cases, five objects were animated simultaneously to allow direct comparison and to shorten the overall survey duration. In the first animation, the five objects differed in transformation time (200, 400, 600, 800 and 1000 ms) to explore how duration affects the perception of a morphing change. In the second, all animations shared the same duration but followed different animation curves (linear, quadratic ease-in, quadratic ease-out, S-curve and quartic ease-in) to analyse how the curve shape influences perceptual outcomes.

All animations were five seconds long, consisting of 120 frames, unless otherwise specified. The discrete change was derived from the morphing animation by setting the transformation duration to 1 frame. To ensure consistent conditions across all stimuli, a standardized studio environment was created in Blender with identical lightning and background settings, which can be seen in Figure 3.

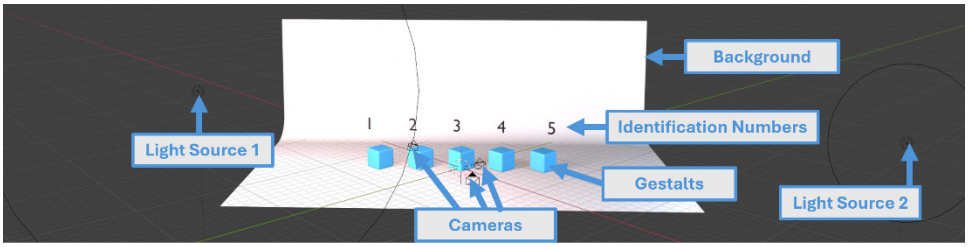


Figure 3: Created studio background in Blender.

The resulting animations are summarized in Table 1. The first row shows the morphing animation, in which the layout changes from a cube to a pyramid, the form becomes narrower, the colour transitions from blue to purple, and the graphic changes from "A" to "B". Based on this animation, four additional versions were created in which only one subgestalt changes, while the others remain constant. For the layout change a cube turns into a pyramid, for the form change the layout starts as a pyramid and during the duration the edges of the pyramid become narrower, for the colour change the blue square changes into a purple square and for the graphic change the label A on a blue square change into a B.

The second row depicts the combined morphing-discrete change, followed by the constant- volume animation in the third row. The fourth row presents the cup transformation.

For the time and animation curve comparison, the animation from row one was used as a base. because the difference of these animations wasn't noticeable enough, without a direct comparison.

Finally, an online survey was conducted via soscisurvey.com (SoSci2025) to reach a broad audience. In this survey, participants are shown the eleven different gestalt changes in a randomised order and asked to evaluate them. After each animation, a questionnaire is presented, containing seven evaluation questions (originally in German), which can be seen in Table 2 in the second column, for the nine animations, with only a single gestalt change.

All questions are answered using a six-point Likert scale (Reinecke, 2022), except the first question, which required a binary "yes" or "no" response. For question 2 to 6, the scale ranged from "I totally disagree" to "I totally agree". A six-point scale was chosen deliberately to avoid a neutral midpoint and to capture clearer tendencies in the participants responses.

Table 1: Animated gestalt changes in blender.

Change	Initial State	Intermediate State	Target State
Morphing change			
Combined morphing-discrete change			
Change with a constant volume			
Changing cup			

The aim of these questions is to assess to what extent the presented gestalt changes fulfill the defining characteristics of morphing and how strongly they were perceived as morphing.

For the two comparison animations, different sets of questions are used. In the time comparison, participants are asked to select the animations that they perceived as a threshold to the aspects, which can be seen in Table 2 in the third column.

Table 2: Questions of the survey.

Questions to:	Single Gestalt Animation	Comparison Animations
1.	Did you perceive a change?	Too fast for morphing
2.	Did you perceive the change as morphing?	Too erratic to be perceived as Morphing
3.	Did you perceive the change as a discrete change?	Classifiable as a discrete change
4.	Did you perceive the gestalt during the change as one entity?	Too slow to be perceived as a discrete change
5.	The target state seems like a new gestalt.	Too smooth to be perceived as a discrete change
6.	Did you perceive the change as smooth?	Classifiable as morphing

For the animation curve comparison, participants are asked to sort the animations in two ways: first, from the softest to the most erratic, and second, from the slowest to the fastest.

As in many online studies, some questions or terms may be misunderstood due to the absence of a supervisor who can provide clarification. To mitigate this risk, the survey included an introductory page explaining all key terminology, and each subsequent page provided the option to revisit these explanations. The explained terms included gestalt, morphing and its defining characteristics, as well as the concepts of additive and integrative gestalt.

Results

The online survey was completed by n = 104 participants, whose responses were included in the analysis. Of these participants 67,31% identified as male, 31,73% as female and 0,96% as diverse. The participants ages ranged from 17 to 57, with the majority between 20 to 30 years old.

Table 3 presents the results for question 1 to 6. For the questions 2 to 6 the statistical significance was assessed using the Friedman test to determine whether overall differences existed. The Friedman test showed an extreme significance for the questions, perceived as morphing ($\chi^2 = 231$, p = 1.50e^−45, W = 0,278), perceived as a discrete change ($\chi^2 = 206$, p = 6, 07e^−50, W = 0,303), perceived as one entity changing ($\chi^2 = 231$, p = 1, 56e^−71, W = 0,425), perceived as a new gestalt ($\chi^2 = 480$, p = 1,18^−98, W = 0,577) and perceived as a smooth change ($\chi^2 = 381$,p = 2.15e^−77, W = 0,458). Subsequently, post-hoc comparisons with a Bonferroni correction were conducted to identify where these differences occurred.

The first question ("Did you perceive a change?") was answered with a "yes" by the majority of participants.

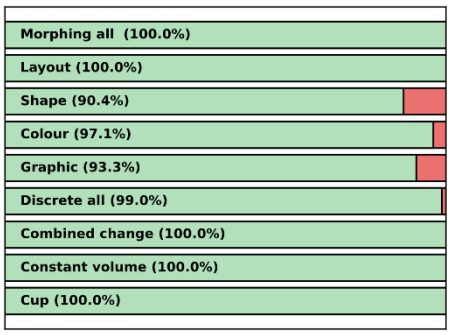
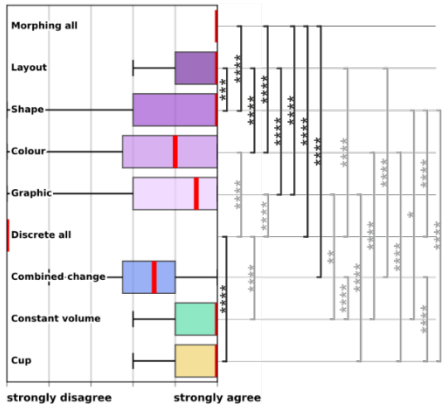
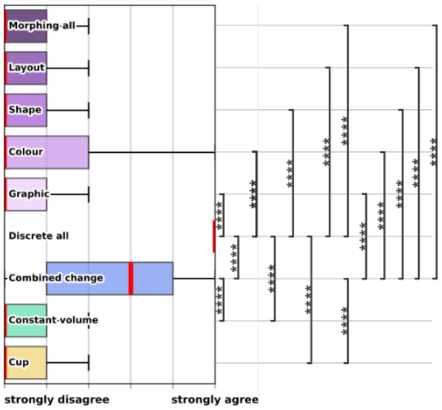
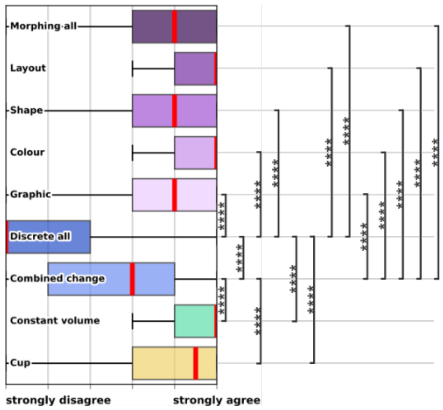
The results of the second question ("Did you perceive the change as morphing?") indicate that, except for the fully discrete change, the animations were generally perceived as morphing. However, variations were observed in the degree of agreement. In particular, animations involving layout changes were rated significantly more as morphing than those involving other subgestalts, with the exception of the combined morphing-discrete change.

These findings are supported by the results of question 3 ("Did you perceive the change as a discrete change?"), which show an inverse pattern relative to question 2. An interesting exception is the combined change, in which layout and shape morphed while colour and graphics changed discretely. This animation was perceived both as morphing and as a discrete change, suggesting a mixed perceptual categorization.

Apart from the discrete and combined changes, which have a significant difference to the other animations, participants generally agreed that the transformations were perceived as one continuous entity and as smooth changes.

Regarding question 5 ("The target state seems like a new gestalt"), the results show that transformations involving more than one subgestalt were more often perceived as resulting in a new gestalt than those with a single changing subgestalt. When only the shape, colour, or graphic changed, the final state was typically not perceived as a new gestalt. In contrast, changes in layout were consistently significantly more associated with the perception of a new gestalt.

Table 3: Results of the singular gestalt changes.

Was a Gestalt Change Perceived?	Perceived as Morphing
	
Perceived as a Discrete Change	**Perceived as One Entity**
	

Continued

Table 3: Continued.

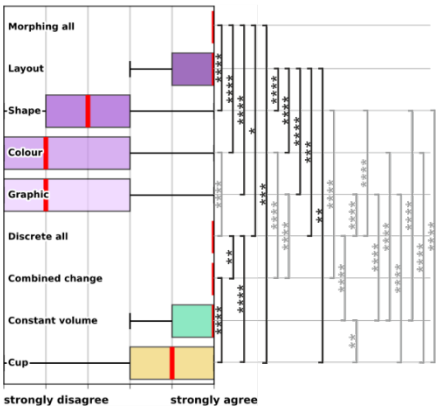
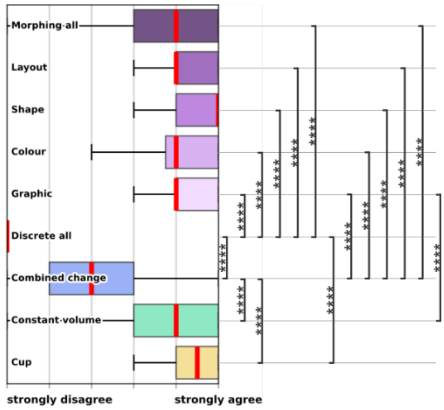
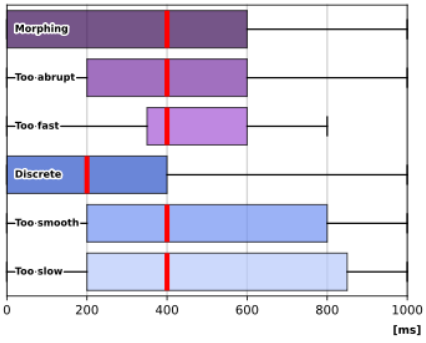
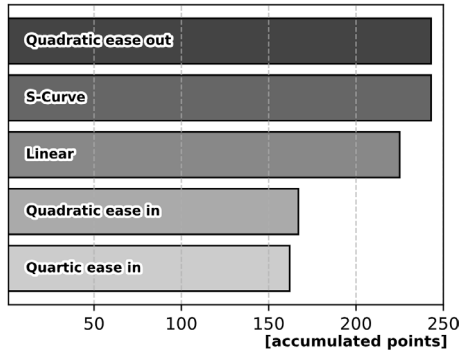
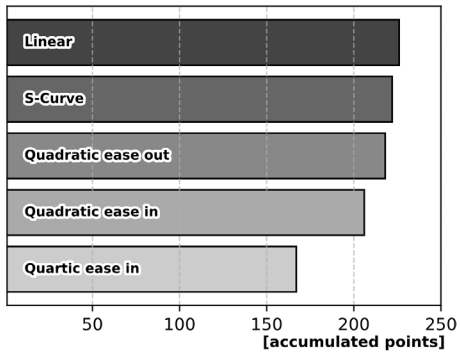
Perceived as a New Gestalt	Perceived as a Smooth Change
	

Table 4 presents the results of the comparison between the five simultaneously displayed gestalt changes. The findings indicate that a duration of 400 ms was perceived by most participants as the threshold between a morphing and a discrete change. To evaluate the overall ranking of the different animation curves, a point-based system was applied, in which curves ranked as the fastest or smoothest by a participant received four points, while the lowest-ranked curves received zero points. The results show the accumulated points over all participants.

Table 4: Results of the five simultaneous changes.

Duration Threshold	Ranking Changing Speed
	

Ranking Smoothness


DISCUSSION

The results of the study demonstrate that morphing is not a discrete state but rather a continuous spectrum in which different parameters influence the perceived effect. The first parameter examined was the type of subgestalt involved in the change. The findings show that although all subgestalts can produce a morphing effect, the strength of this effect varies. Changes to the body-related subgestalt, namely layout and shape, were rated more as morphing, while surface-related subgestalts, such as colour and graphics, elicited a weaker morphing impression. Especially layout has a significant difference to the other subgestalts, while not having a significant difference to the completely morphing change.

Although all subgestalts fulfilled the formal characteristics of morphing to a similar degree, a clear difference emerged in whether the final state was perceived as a new gestalt. Here, layout changes have a significant stronger influence, suggesting that the perceptual difference between the initial and final states correlates positively with the perceived strength of the morphing effect. However, the results for the discrete change indicate that fulfilling the morphing characteristics remains a necessary condition for the effect to occur.

If only one subgestalt changes, layout changes tend to produce the impression of a new gestalt, whereas changes in shape, colour, or graphics are generally perceived as modifications of the same gestalt. When comparing the morphing-discrete change to the single-subgestalt changes, the combined transformation produced the lowest perceived morphing effect yet a non-significant difference in being perceived as a new gestalt compared to layout. This can be explained by its perception as more erratic, abrupt, and faster than the other changes. The combined change also showed a significant lower level of agreement regarding the perception of a single continuous entity. As this animation was the only one classified simultaneously as morphing and as a discrete change, it can be hypothesized that combinations of different change types may be perceived as two separate gestalts transforming rather than one continuous transformation. The constant-volume change, which involved only a layout transformation, can be directly compared with the standard layout change. The results don't show a significant difference in one of the questions. This indicates that, for a morphing effect to occur, the body does not necessarily need to increase or decrease in size, shifts in proportion alone are sufficient. The cup transformation, a change in which all subgestalts were modified, including proportional adjustments to the layout, was perceived differently. Despite involving all subgestalts, the final state was significantly less often identified as a new gestalt compared to the other full-gestalt changes. This suggests that particularly the transformation of the basic body structure within the layout has a strong influence on whether the final state is perceived as a new gestalt.

The analysis of duration and animation curves further show that a gestalt change is perceived as too fast or abrupt when the amount of change (changing volume) is too high for the given timeframe. The results in Table 3 show that for this linear animation, approximately 400 ms represents the threshold between a morphing and a discrete perception. However, this threshold is

likely dependent on the gestalt being changed and varies with the magnitude of the changing volume, but confirms that such a threshold does exist.

In the comparison of animation curves, linear changes were perceived as both the smoothest and of average speed, likely because the changing volume was evenly distributed over the transformation duration. The high ratings for the quadratic ease-out and S-curve animations indicate that transformations with an early leap of changing volume are perceived as faster than those with a late leap, even when the latter involves a stronger leap. The smoothness ratings further show that the more evenly the changing volume is distributed over time, the smoother the transformation is perceived.

SUMMARY

This paper presents an online study in which eleven different gestalt changes were evaluated to analyse the parameters influencing the characteristics of morphing transformations. The findings show that morphing is a gestalt change in which different parameters can intensify, weaken or even disrupt the perceived effect. The results indicate that the type of subgestalt has a significant impact on this perception. Changes affecting the body of the object produce a stronger morphing impression, whereas surface-related changes contribute less to the effect. A similar pattern was observed in the perception of the final gestalt: transformations involving layout changes were more often perceived as resulting in a new gestalt than those limited to surface modifications.

Furthermore, the study highlights the crucial role of changing volume distribution over time. When the degree of change is evenly distributed across the transformation duration, the result is perceived as smooth and thus more characteristic of morphing. In contrast, spikes or uneven distributions of change volume lead to perceptions of abruptness, diminishing or even breaking the morphing effect. Overall, the findings demonstrate not only how morphing can be effectively achieved through the adjustment of key parameters but also how these parameters influence the perceptual qualities of a gestalt change to varying degrees. These insights enable a more precise categorization and combination of gestalt change types, providing a foundation for future research on additional parameters and their effect on user perception and experience.

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