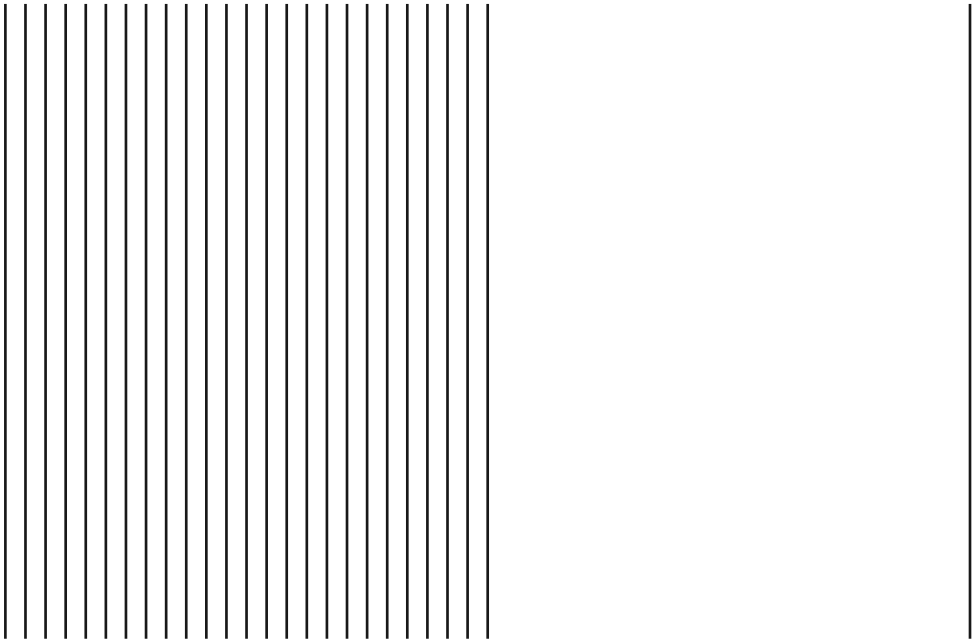
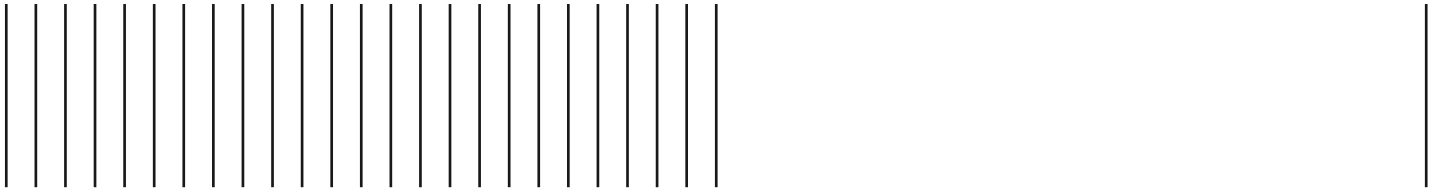
Oppel-Kundt Illusion

The Oppel-Kundt illusion is a phenomenon that when a linear space is subdivided into a number of segments, it is reported to appear longer than an unfilled space of the same size.

First reported by Oppel in 1855, there is no clear explanation on the mechanism of this geometrical optical illusion till date.



Let us study the illusion in detail, try to understand how it works and explore how do changes in characteristics of the filled and unfilled spaces affect the illusion created.



Look closely at the two spaces shown in the illustration above. One can see that the space on the left is filled with lines while the right is unfilled. Are both the spaces equal or does one appear to be larger than the other?

First, let us construct similar spaces by dividing a space in half and progressively filling one of the halves to find roughly when the illusion starts to be apparent.

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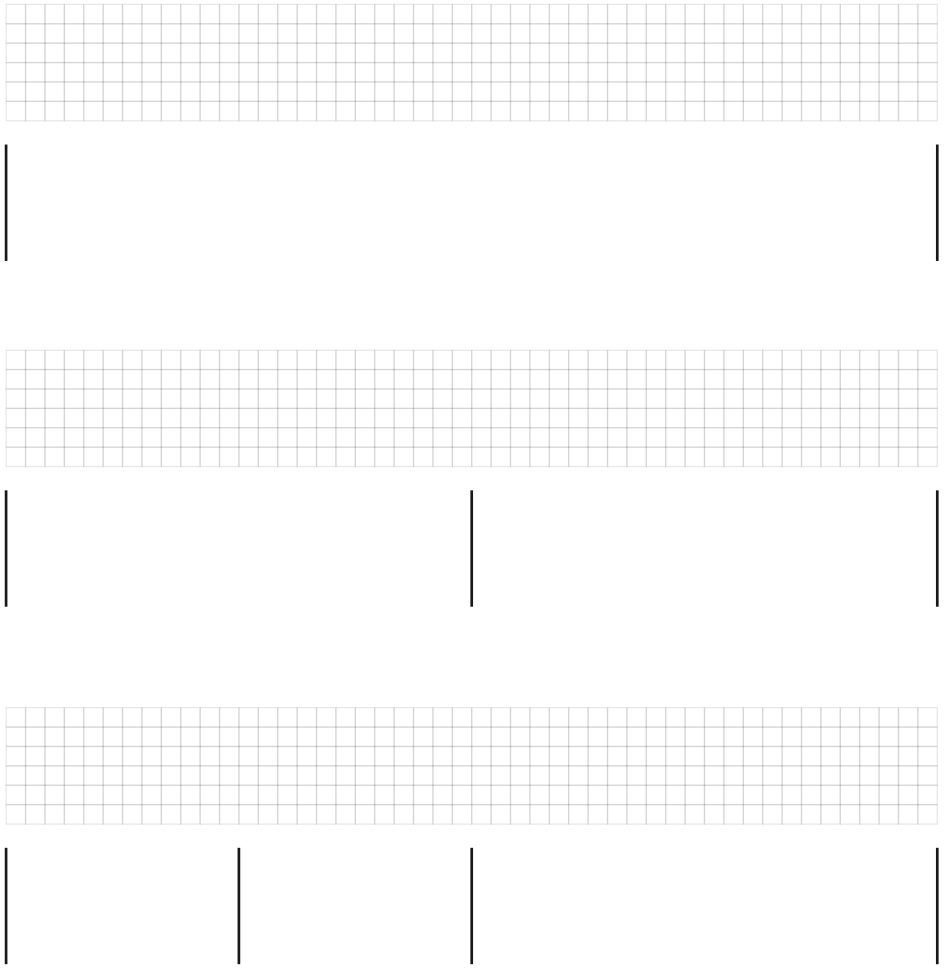
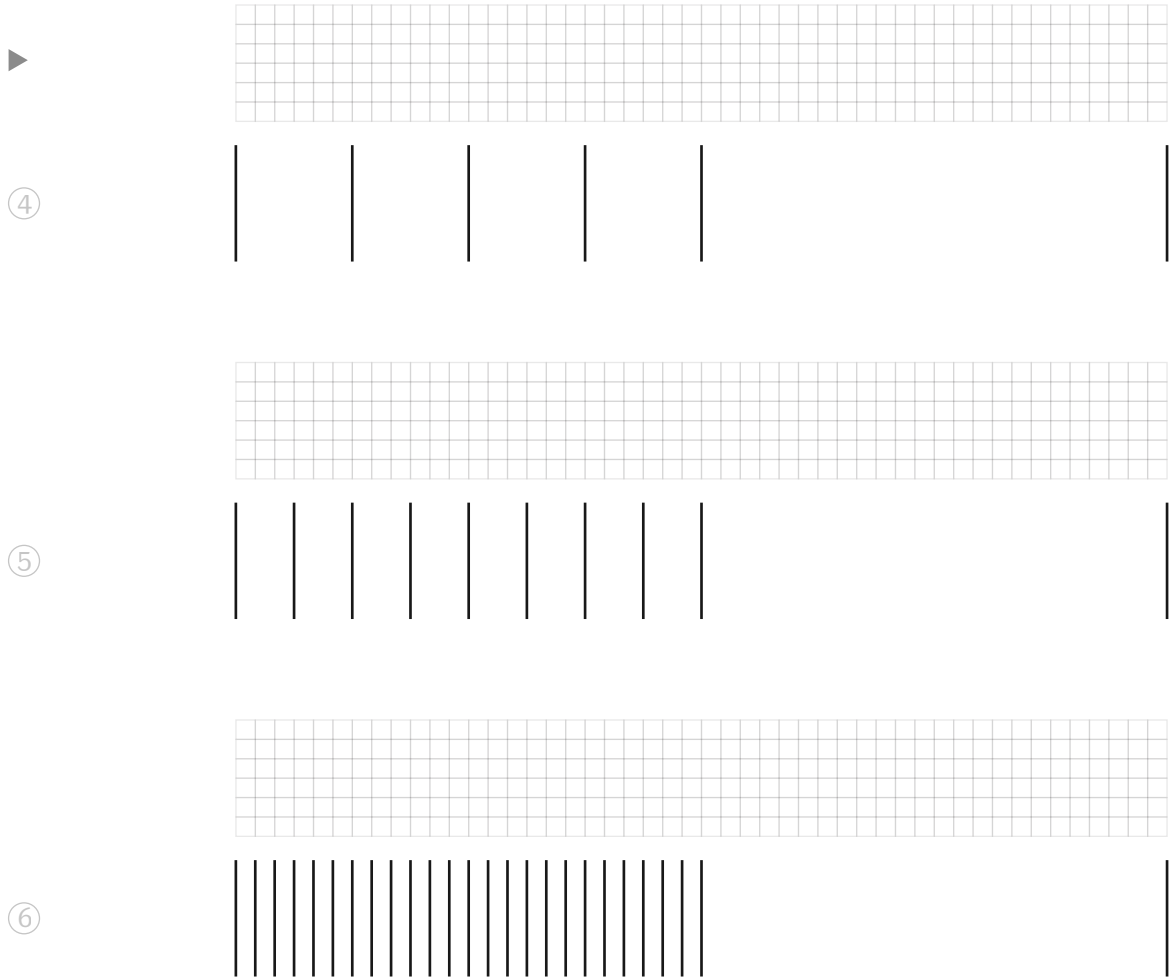


One can see that the illusion becomes evident from step 4 and gets stronger as the space is divided/filled even further.



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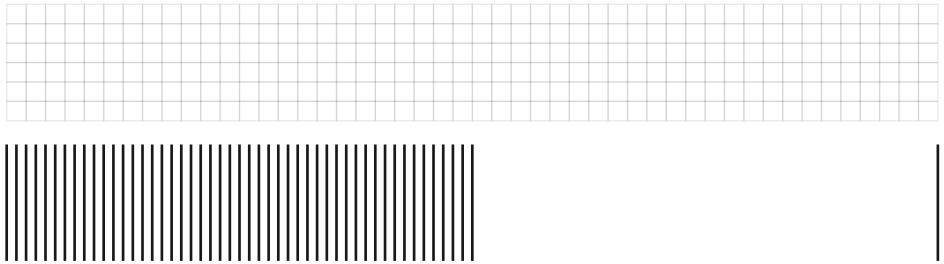

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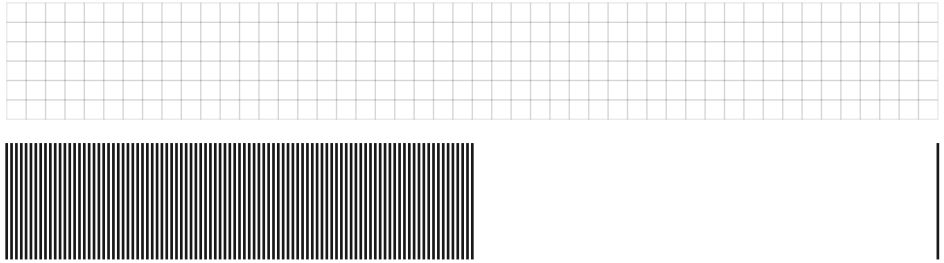

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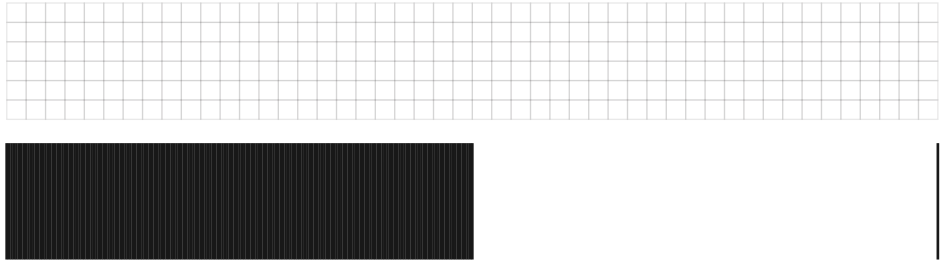
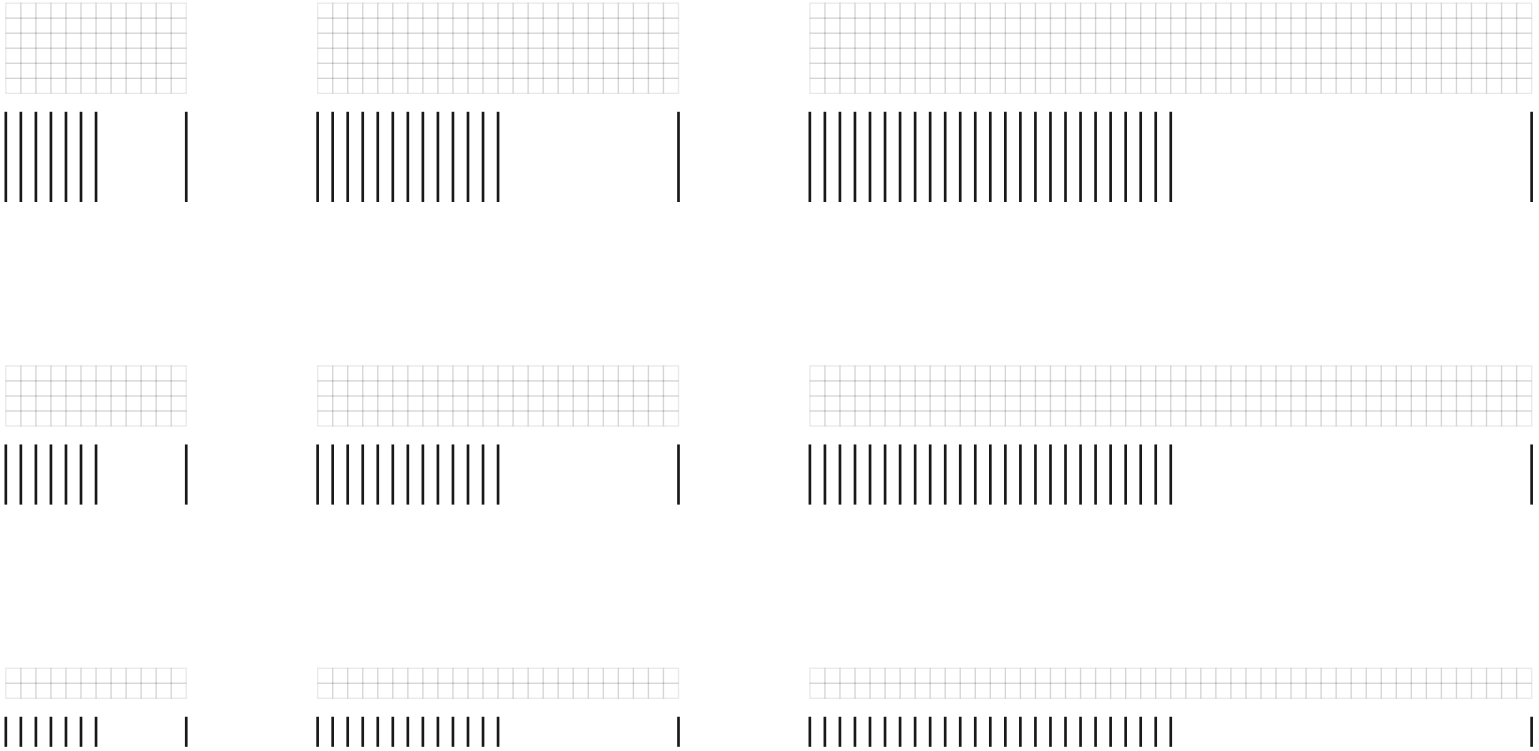
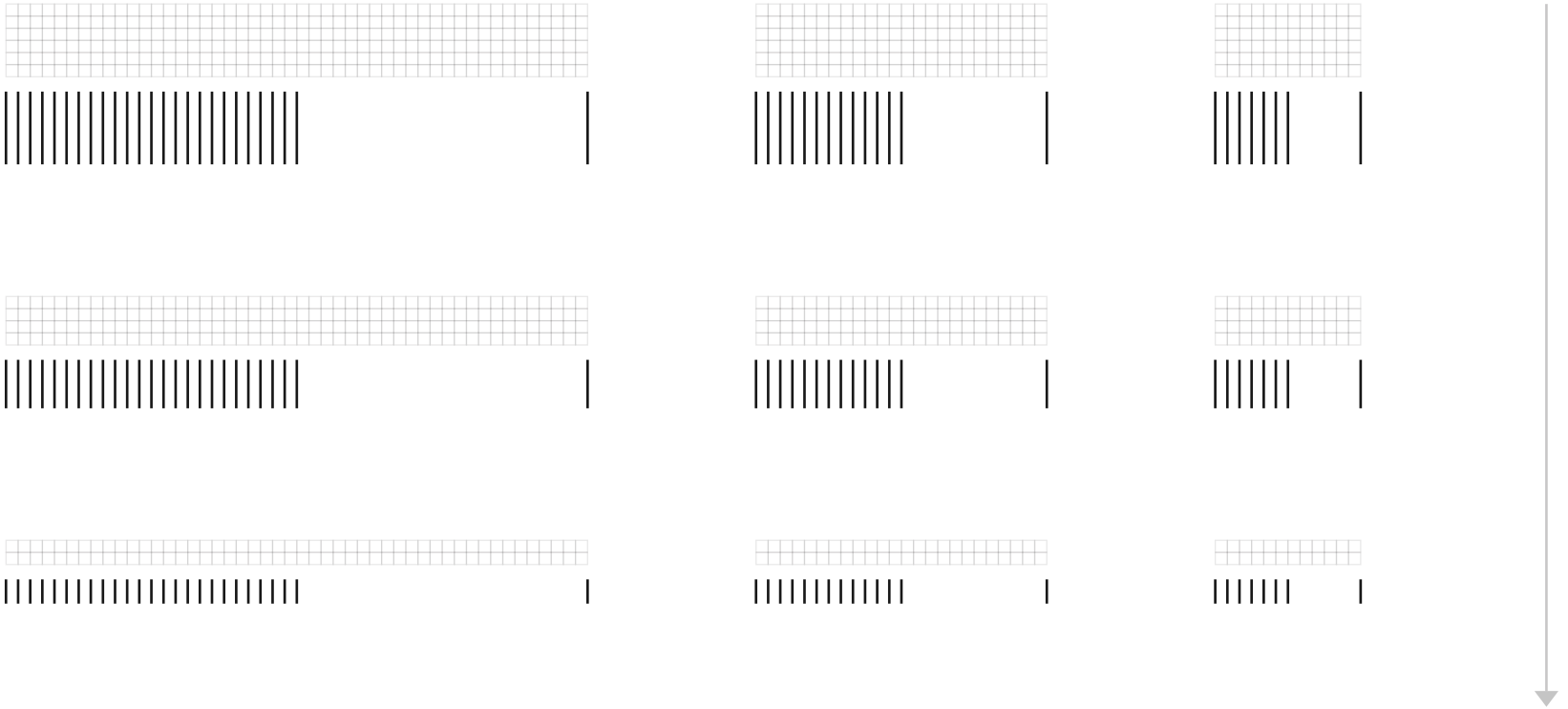


Variation in length and height of spaces.

Spaces of varying lengths and heights are created
to understand its effect on the illusion.

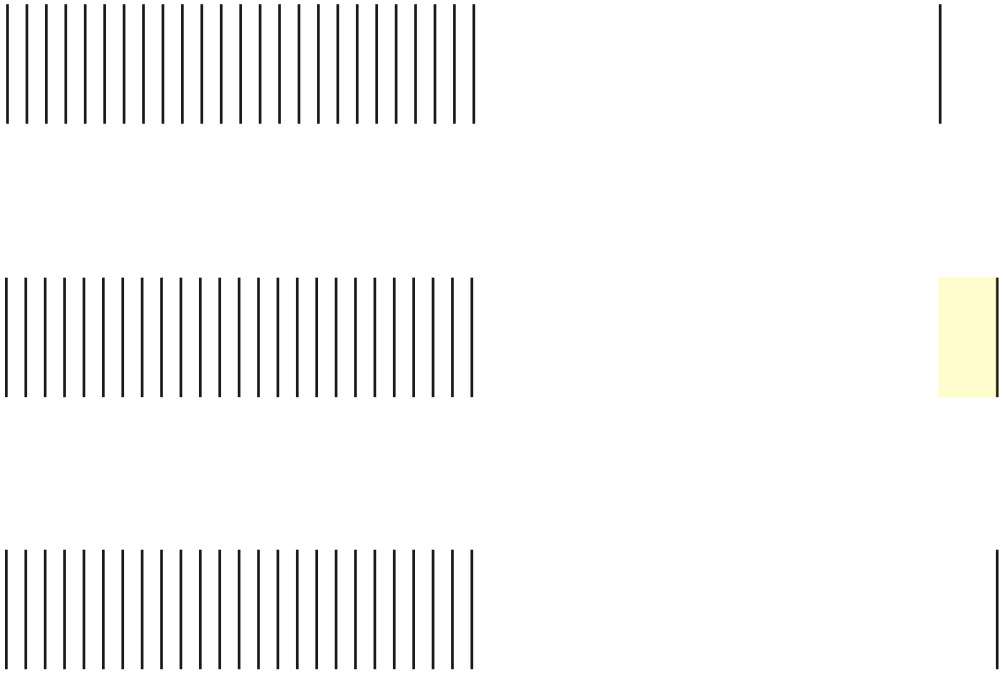




The illusion becomes more evident when the length of the spaces are decreased.

Also, the illusion appears to get weaker when the height of the spaces are reduced.

What if we optically balance the two spaces? Let us try to understand how much optical correction needs to be done so that the two spaces will appear to have the same length.

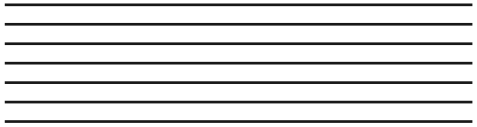


Visual adjustment added is highlighted in yellow.

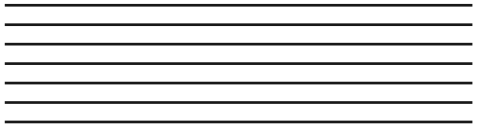
Adding an adjustment roughly equivalent to the length highlighted appears to balance the filled and unfilled spaces.

Direction of division or fill.

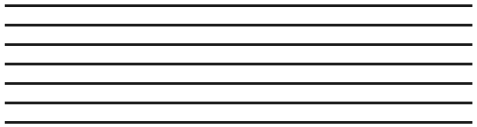
What happens when the space is divided horizontally compared to vertical divisions?

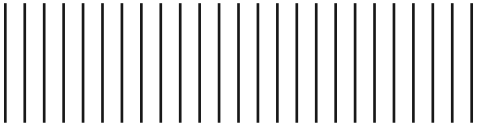


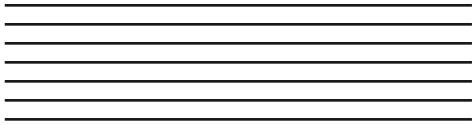
The illusion happens even when the space is divided horizontally. Let’s once try to visually balance the spaces created.

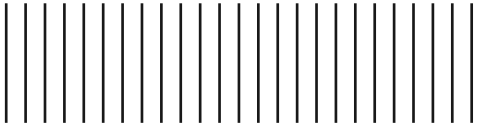


Visually balancing both the spaces would require optical adjustment in length, as highlighted here.









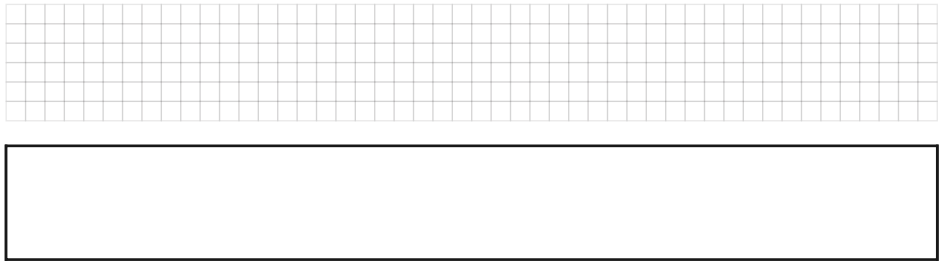
Interestingly, optical adjustment required for horizontal subdivisions is slightly more than that of vertical divisions.

Exploring effects of fill style

What happens when the space is filled in different styles?

When both the spaces are well defined with a boundary, the illusion seems to be reduced.

This is an interesting case since the strength of the illusion is vastly reduced when the spaces are well defined by a boundary. Let us again construct the spaces with defined boundaries and try to identify the point where the illusion becomes apparent.

① 

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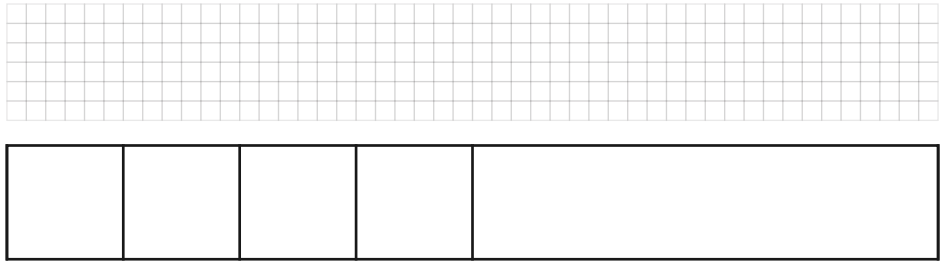

Here, the illusion becomes somewhat evident at step 5 and gets stronger in step 6. But, there is a twist!

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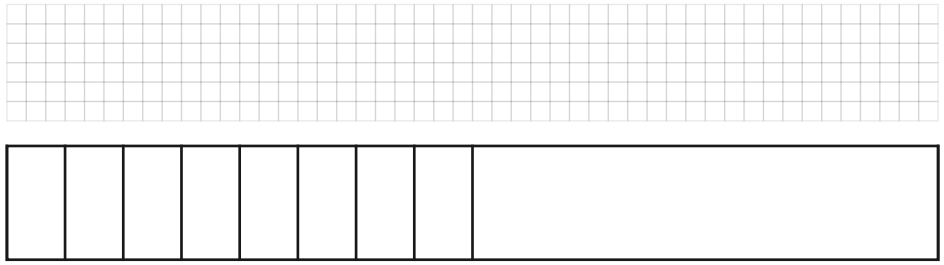

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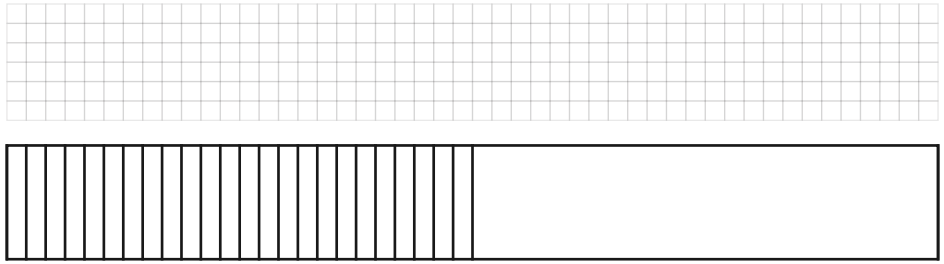

As the space is further filled and reaches closer to a solid fill state, the illusion appears to get weaker.

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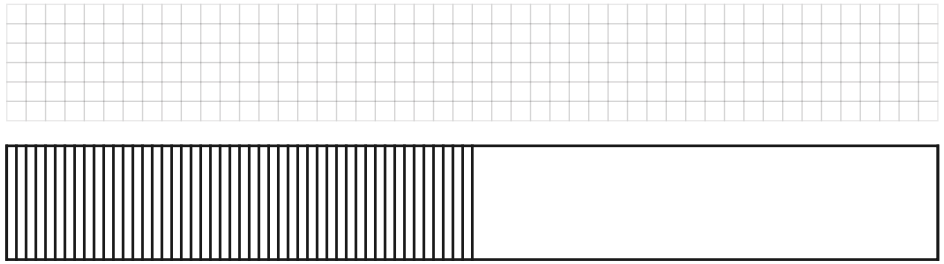

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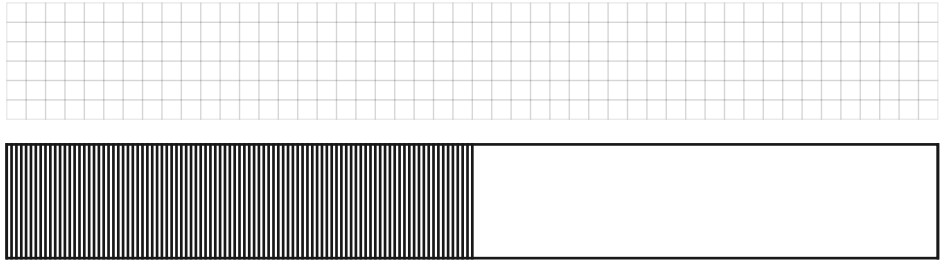

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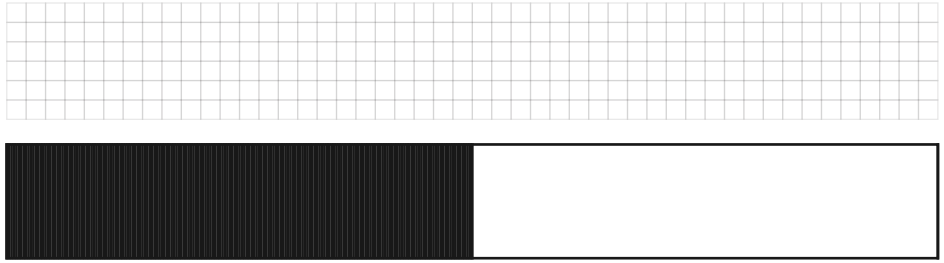


Exploring effects of fill style

What happens when the space is filled in different styles?

When one of the spaces is given a solid fill and the unfilled space is bounded by an outline, the illusion seems to be reduced to such an extend that it is almost non-existent.

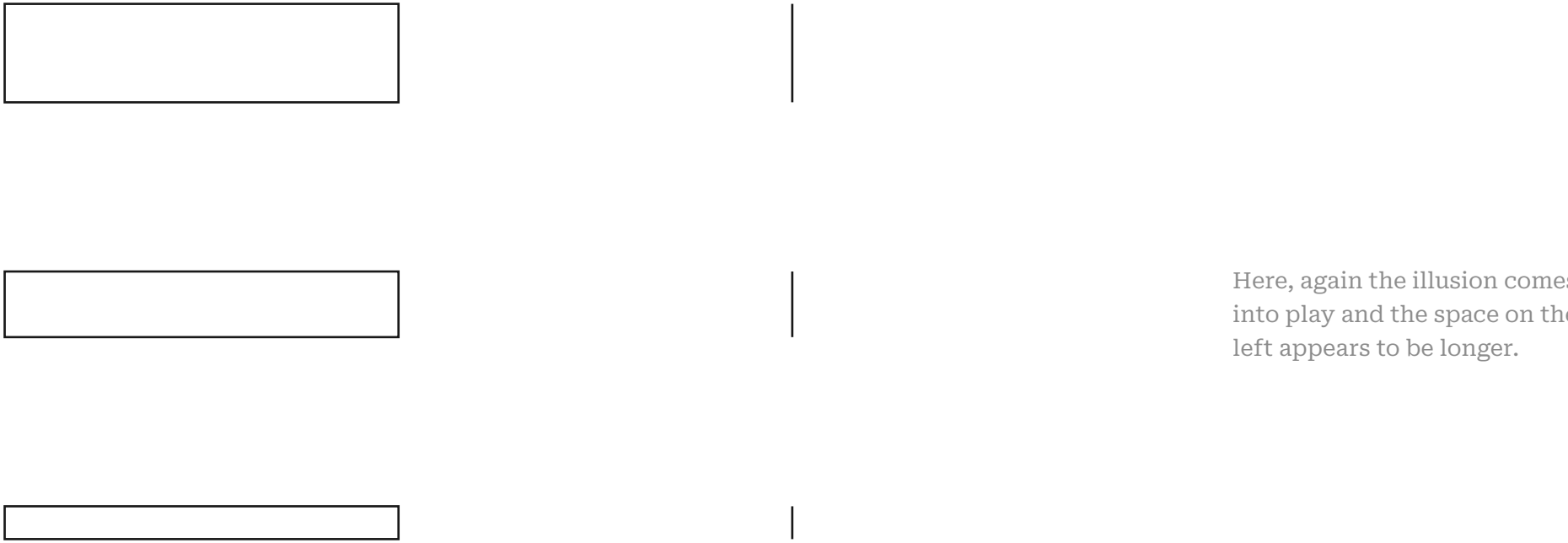
Exploring effects of fill style

What happens when the space is filled in different styles?

When both spaces are given a fill, the higher value side can be considered as the unfilled space. The length of such an unfilled space appears to get longer as it gets lighter (increased value).

Exploring effects of fill style

What happens when the space is filled in different styles?



Here, again the illusion comes into play and the space on the left appears to be longer.

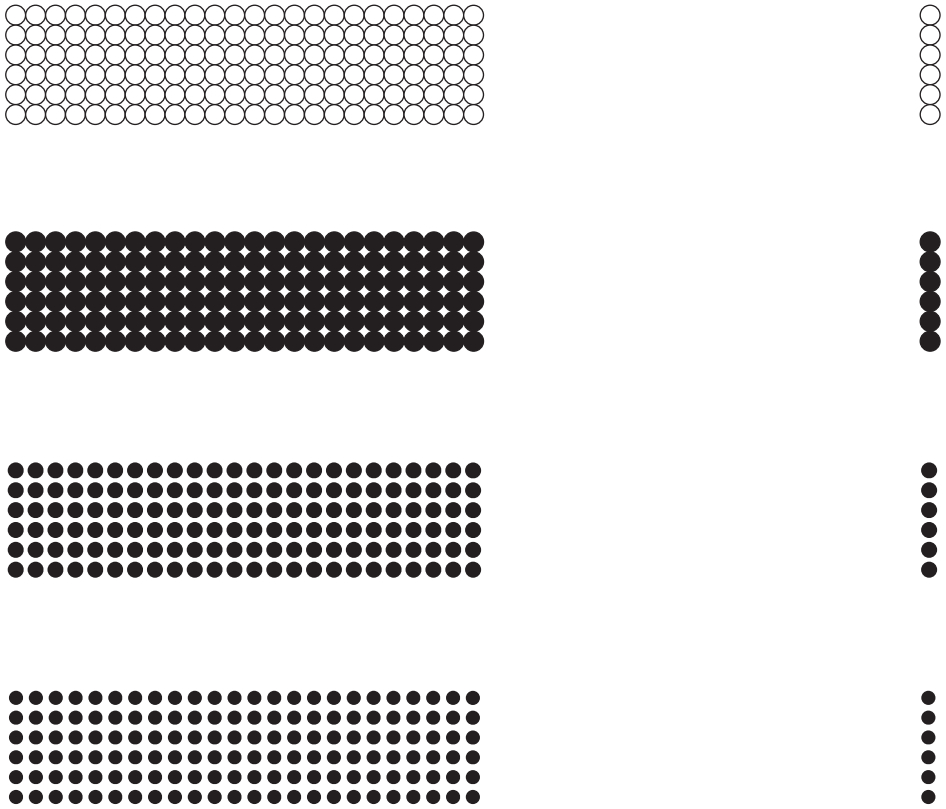
Exploring effects of fill style

What happens when the space is filled in different styles?

Same happens when the space is given a solid fill.

Exploring effects of fill style

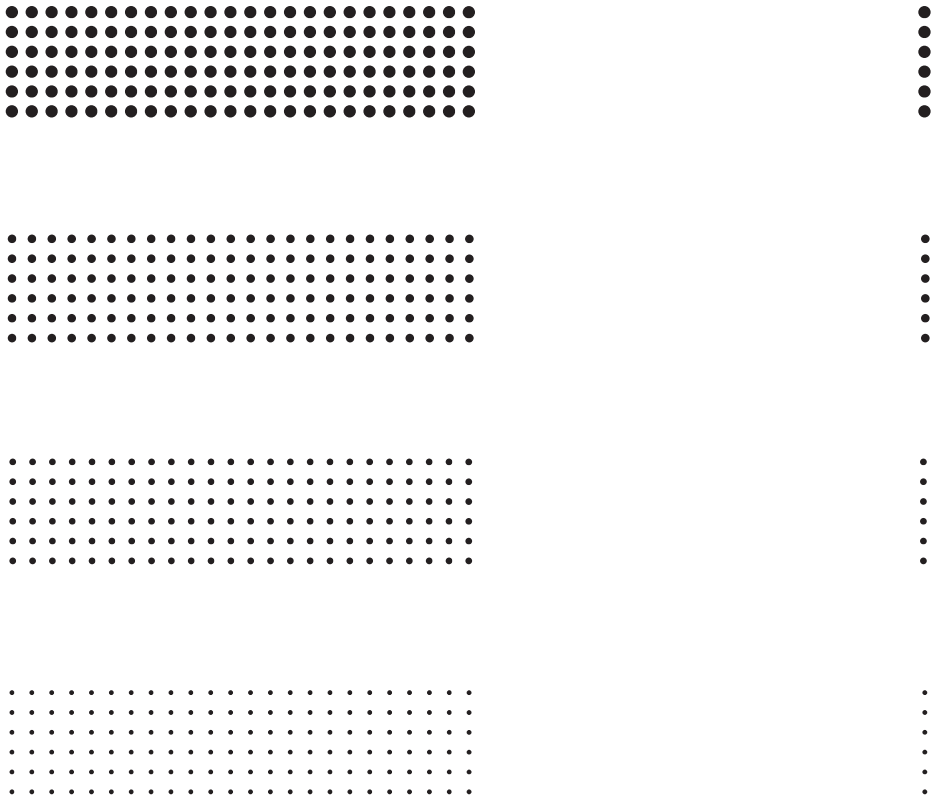
What happens when the space is filled in different styles?



In this exploration, uniform patterns are used to divide and fill up the space.

Exploring effects of fill style

What happens when the space is filled in different styles?

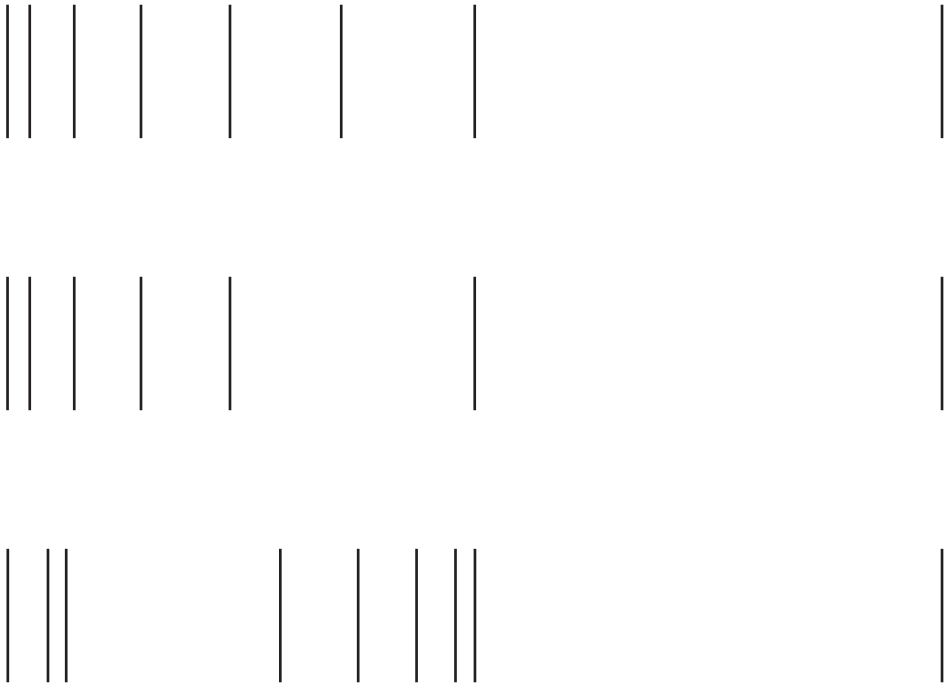


As one can see here, using patterns as fill doesn't seem to have much affect on the illusion. The unfilled space might appear to be getting progressively longer as the size of dots in the pattern becomes smaller.

The various types of fills can be seen to vary the strength of the illusion. For example, the illusion seems to reduce when the space boundaries are more defined in ways such that it gives more visual cues for our eyes to pick up the length of spaces more strongly.

What about a gradation in fill?

What effects does different types of gradation to the fill brings to the illusion?

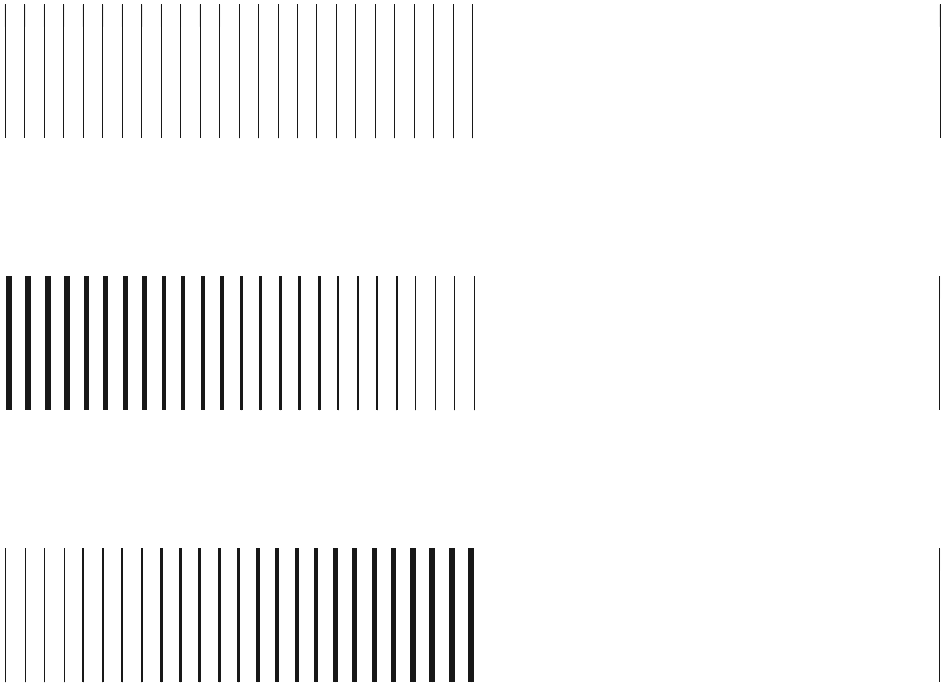


The illusion is present when the gradation is even or uneven. But as the gradation becomes more uneven and start having larger gaps (which makes it look less filled), it affects the illusion.

The more ‘unfilled’ the filled space appears due to gradation, the weaker the illusion gets.

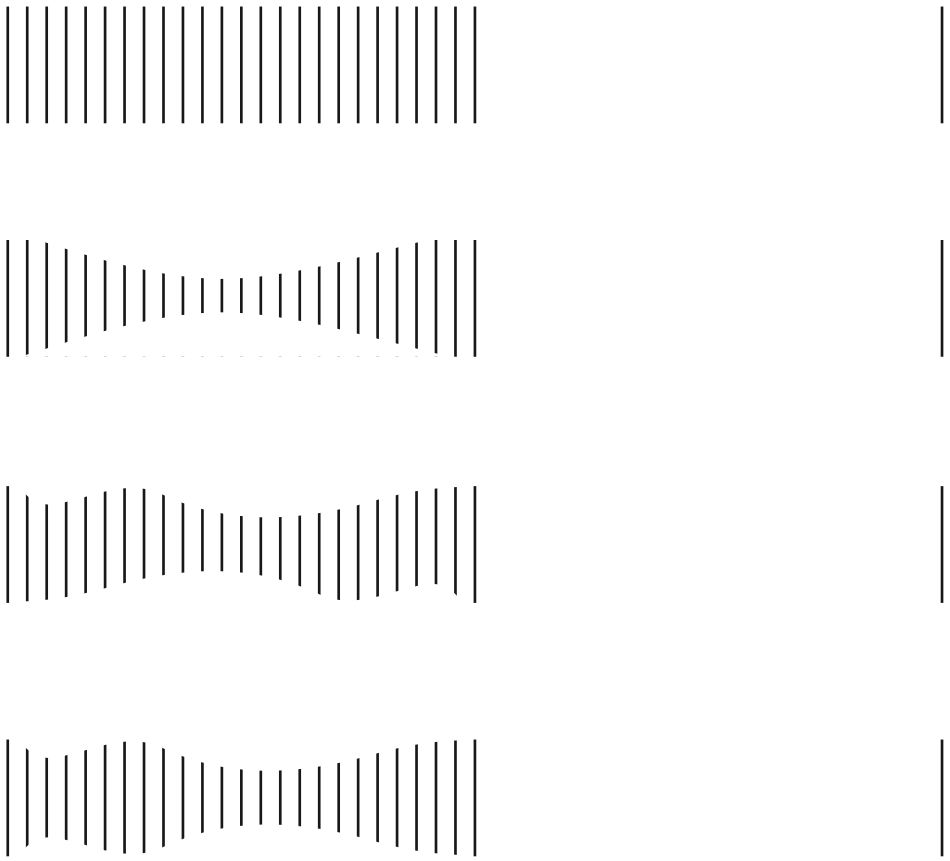
What about a gradation in fill?

What effects does different types of gradation to the fill brings to the illusion?



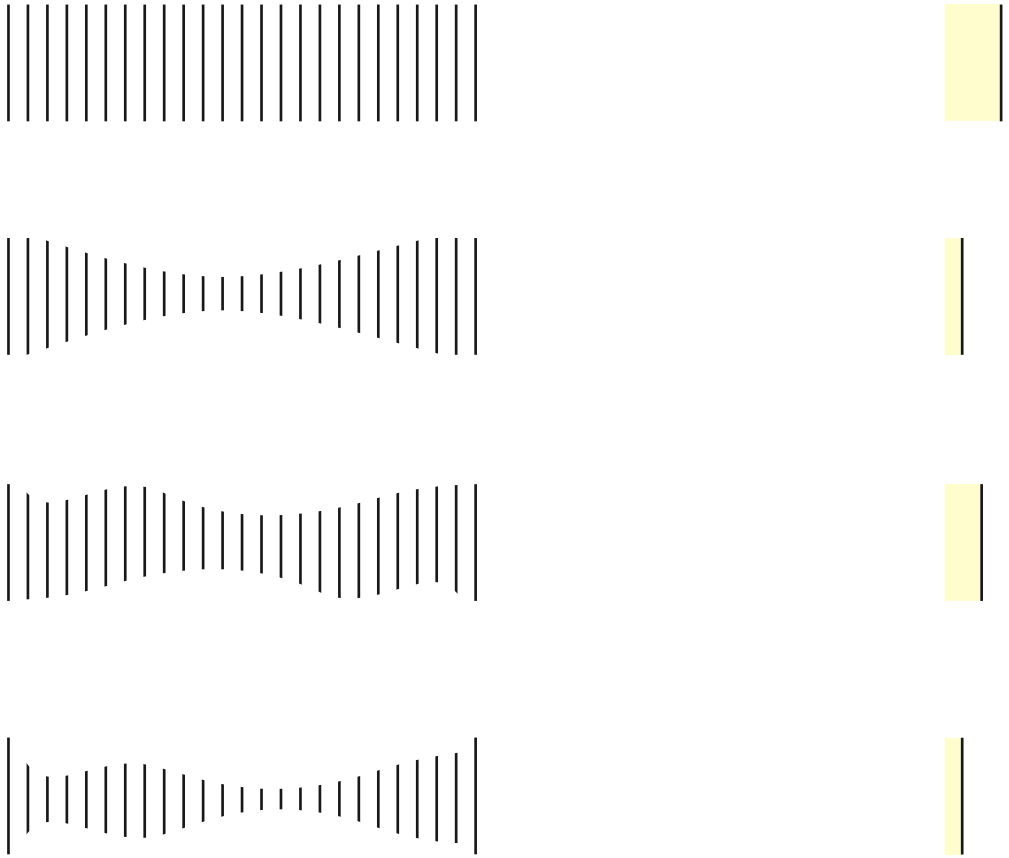
In this case, depending on the direction of uniform gradation, the unfilled space may appear longer or shorter compared to the unfilled space in the example without gradation.

What if the filled space is non-uniform?



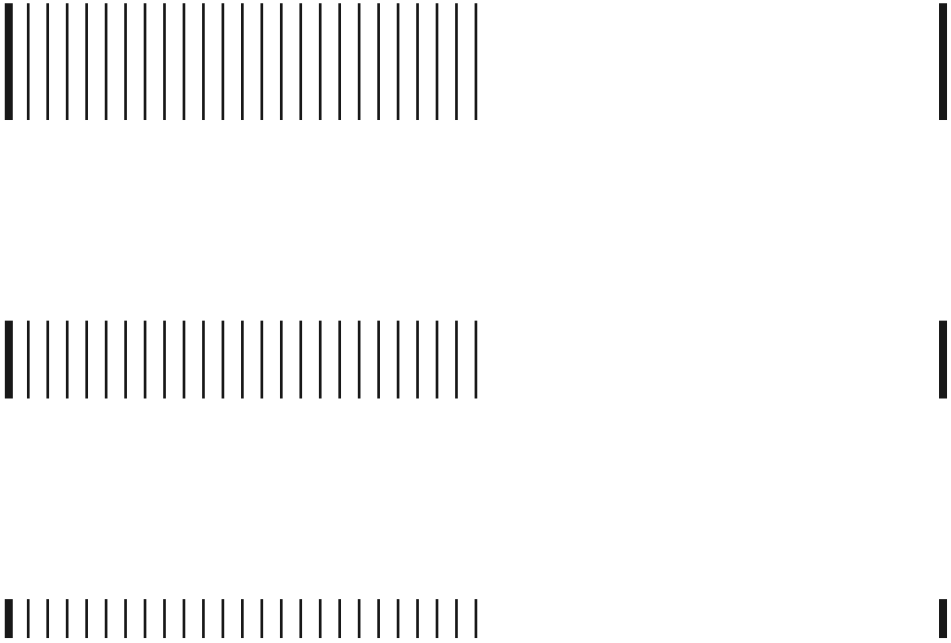
The illusion is still present when the filled space is non-uniform.

What if the filled space is non-uniform?



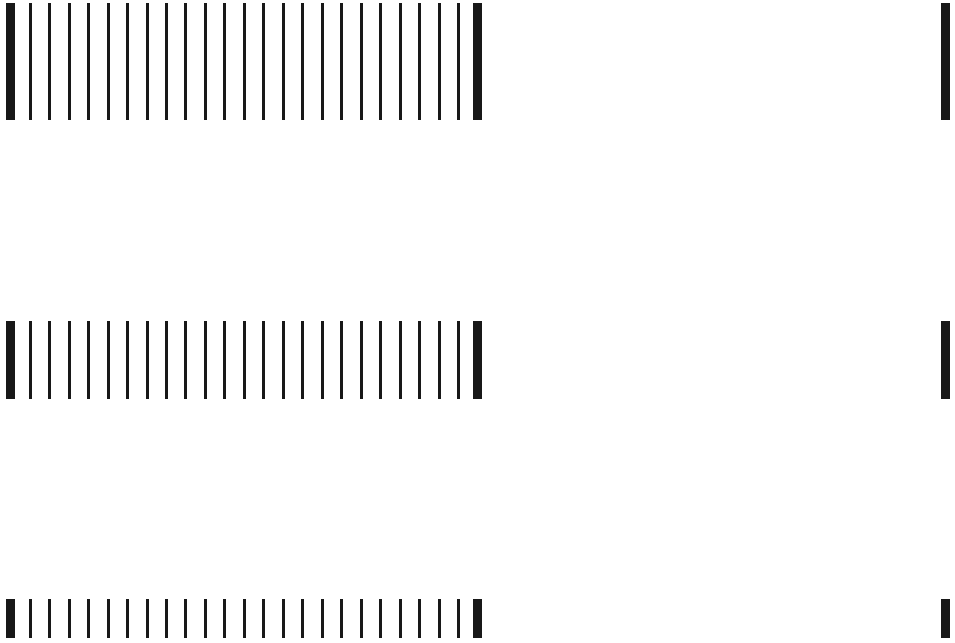
The optical correction added to balance the two spaces are found to be lesser when the filled space is non-uniform.

What will happen when the starting and ending of both the spaces are more defined?



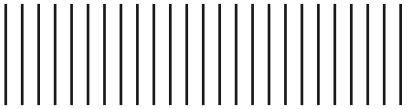
Defining the two extreme ends of the overall space does not seem to make much difference.

Let’s take it a step further and define the centre where the two spaces meet.



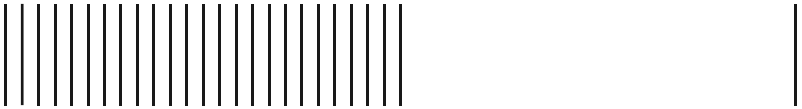
In this case, the spaces appear to create a confusion regarding the filled space being longer or if they are equal. Yet, it is more probable that one might find the filled space to be longer.

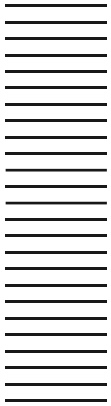
Exploring affects of orientation

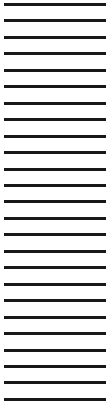


The illusion can be seen when the spaces are in vertical orientation. One interesting thing to be noticed is that the unfilled space in vertical orientation appears to be longer compared to the horizontal.

Exploring effects of orientation

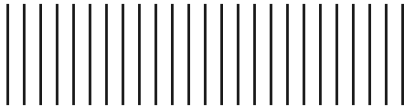


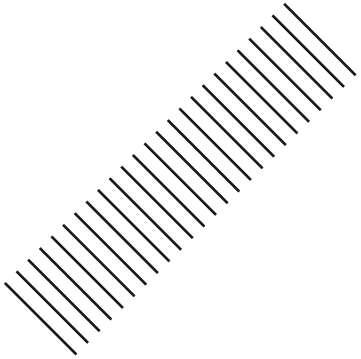




Then what about when the positions of filled and unfilled spaces are reversed? Does the unfilled space look smaller when it is at the bottom, compared to when it is on the top?

Exploring effects of orientation





Diagonal orientation does not make much effect on the illusion as one can see here.

Oppel Kundt illusion vs real life objects

Here, we are trying to arrange a number of cans and see how the illusion happens.

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The illusion appears to occur the same way it appears with arrangement of lines.

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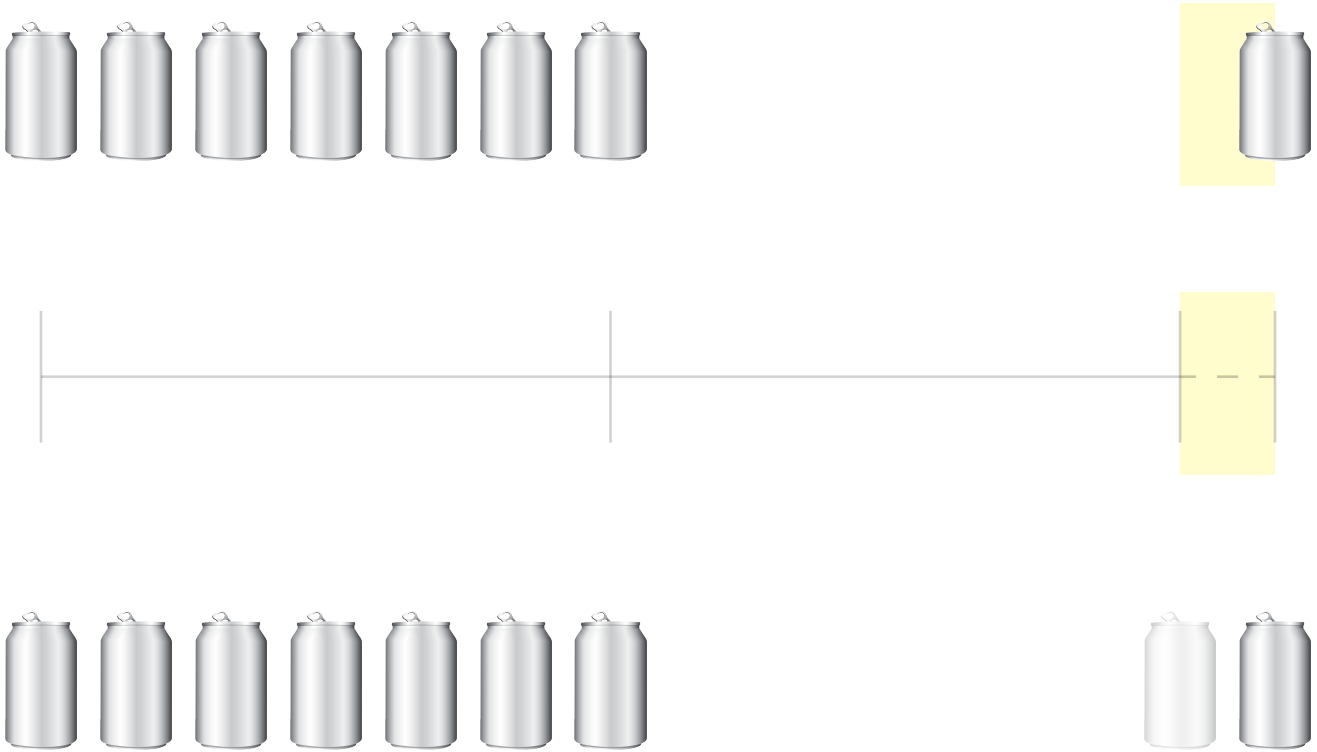
Let’s attempt to visually balance the two spaces.

Oppel Kundt illusion vs real life objects



It can be seen that the space equivalent to one can needs to be added to the unfilled space to make it look the same length as the filled space.

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Summary

Oppel Kundt illusion can be broadly explained as: a divided/filled space appear to be longer compared to an undivided/unfilled space of the same size.

In this documentation, the illusion was studied by varying certain features of the spaces created and understanding what effetcs do these changes bring about to the illusion. Findings from the explorations are listed below:

- The illusion appears only after certain number of divisions are added and increases in strength as the number of divisions are increased further.

- The illusion gets stronger when the overall length of both the spaces together is smaller.

- The illusion also gets weaker when the height of the spaces are shorter.

- The visual correction required to be added to make the spaces appear equal is more when the divisions are made horizontally compared to vertical divisions.

- The illusion gets weaker when the spaces are well defined by a boundary.

- Various types of fills when applied to the filled space can be seen to vary the strength of the illusion created.

- Various types of fills and gradations when applied to the filled space can be seen to vary the strength of the illusion created. The basic idea is that when the divided space appears to be ‘less filled’ the illusion gets weaker and vice versa.

- The illusion gets weaker when there are stronger visual cues that define the spaces.

- The perceived length of the unfilled visual field changes with orientation. It appears to be longer in vertical orientation than in horizontal even when they are of the same size.

- The illusion can be seen when similar filled and unfilled spaces are created by arranging real objects.