# Mixing up shapes

## - 70% mix-up of angles and curves when using haptic touch

In everyday life individuals are bombarded with symbols and illustrations providing important, sometimes life-saving information, e.g. 'poisonous', 'flammable', 'fire evacuation route', etc.; however this information is not accessible to all of us.

One in 30 Europeans experiences sight loss, including one in three individuals over 65 years of age (European Blind Union). These individuals cannot read the newspaper or the name of a street, recognise a face or read a symbol, use a map or an illustration: they rely on their sense of touch. Sense of touch allows one to perceive temperature, pain and pleasure; touch combined with movement is referred to as 'haptic touch'. Haptic touch enables recognition of objects, letters, symbols, illustrations, and so on.

Symbols and illustrations embrace the conventional shape of certain phenomena (Oxford Dictionary), i.e., the configuration of angles, curves and straight lines. Attempts to make symbols and illustrations readable using haptic touch usually involve producing an embossed surface; rarely, if at all, are the symbols and illustrations altered (e.g. the straightness and/or curviness of specific lines) to make it easier to perceive them fast and accurately.

**Are certain shape feature distinctions discriminated faster and more accurately than others,**
- straight line ↔ angle distinctions
- angle ↔ curve distinctions
- curve ↔ straight line distinctions

**and what discrimination strategies are at use?**

STRAIGHT LINE ↔ angle distinction  ANGLE ↔ curve distinction  CURVE ↔ straight line distinction

Straight line ↔ angle distinctions and curve ↔ straight line distinctions are discriminated both faster and more accurately than angle ↔ curve distinctions: The distinction between straight lines and angles, and between straight lines and curves are clearer than that between angles and curves.

**Straight line ↔ angle distinctions and curve ↔ straight line distinctions are perceived pre-attentively; angle ↔ curve distinctions attention dependent.**

|  | Mean exploration time | Mean accuracy |
|---|---|---|
| *Straight line ↔ angle distinctions* | 14.7 sec. | 89% |
| *Angle ↔ curve distinctions* | 31.7 sec. | 34% |
| *Curve ↔ straight line distinctions* | 16.5 sec. | 89% |

*"When the shape has more than two lines, then it is a curve; not an angle"*
*"A curve is more open than an angle"*

**There is a 70% mix-up of angles and curves when using haptic touch**

**Three discrimination strategies are at use**, and all three mix up angles and curves:
- **The figure identity strategy** performs a specific analysis of the line quantity in each angle, curve and straight line. Based on the quantity of lines, it then recognises and names the shape features; according to a set of rules: "An angle has two lines"; "When the shape has more than two lines, then it is a curve; not an angle".

- **The global characteristics strategy** notices differences in the global shape: "I search for differences in the global shape: I don't think of them as angles or curves". It analyses the global shapes only "When they have too many lines", e.g: they are "'zigzags'"; they have "one short and one long"; they have "nothing in another direction".

- **The touch vision strategy** notices differences in the global shape and associates the global shapes to regular print letters: "The regular print 'z' is a symbol for all global shapes that resemble the z". When an instant association between the global shape and a regular print letter does not occur, then it analyses the global shape, e.g: "I recognise them because I count lines".

**The figure identity strategy has three levels of attention; it ranks a feature conjunction [line quantity and ("inducted") shape feature name] as the most important target-discriminating feature. The global characteristics strategy and the touch vision strategy have two levels of attention; both rank one separate feature [("deducted") shape feature name] as the most important target-discriminating feature.**
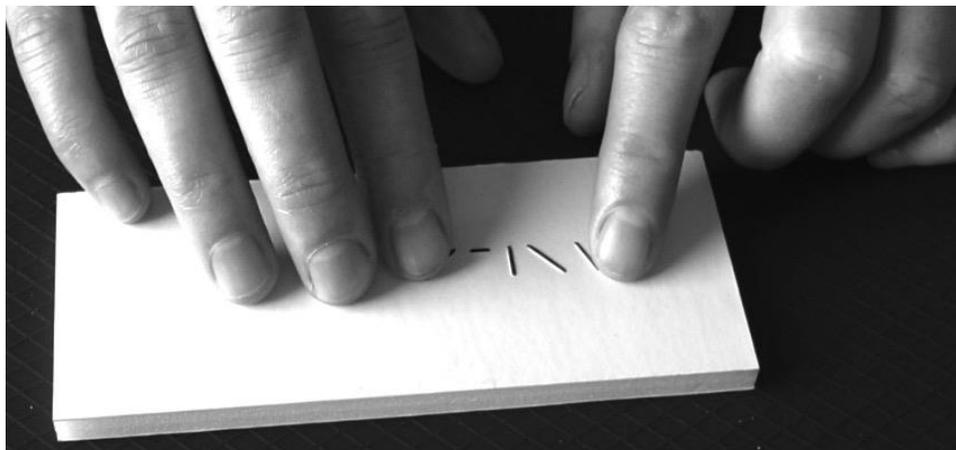
*"Angles and curves are the same thing"*
*"An angle is a pointed or sharp curve. Also an angle is curved"*

**There is a 70% mix-up of angles and curves when using haptic touch**
**… which makes interpreting symbols and illustrations problematic**

The accessibility symbol provides an example of the problems caused by mixing up angles and curves: The mix-up makes it hard for the reader to make out the body and the wheel. His or her actively exploring fingers – haptic touch – get caught up in the wheel (circle) and he or she thus fails to detect the hip and knee (angles): this makes it impossible to discriminate the accessibility symbol from any other circle.

The accessibility symbol (in which the white lines would be embossed):
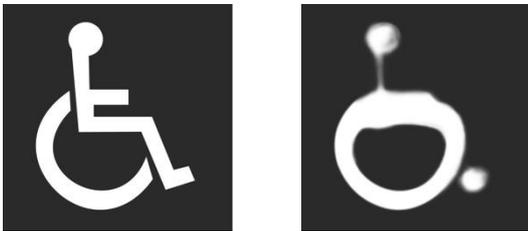


(a) the actual symbol   (b) how the symbol may be represented
                        if angles are perceived as curves

The Euro symbol (€) provides another example. If curves and angles are mixed up, this may very easily be mistaken for the capital E. Thus, miscommunication is inevitable: Those using vision describe the symbol as a vertical curve with two horizontal lines in the middle; those using haptic touch describe it as two angles, one on top and on the bottom, with a horizontal line in the middle.
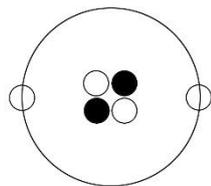
The Euro symbol (in which the black lines would be embossed):



(a) the actual symbol   (b) how the symbol may be represented
                        if curves are perceived as angles

Mixing up curves and angles also causes problems at school. Consider an illustration of an atom, in this case helium. Those who perceive the nucleus as a square, rather than four circles will find it difficult to grasp the concept the illustration is intended to convey, the chemical composition of the atom, and will think of the nucleus a single entity whilst his or her teacher and peers conceive it as two (circle) protons and two (circle) neutrons.

The helium atom (in which the black lines and surfaces would be embossed):
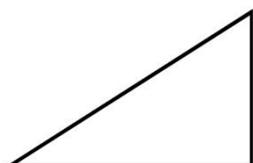


(a) the actual
illustration
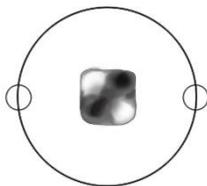
(b) how the illustration may be represented
if curves are perceived as angles

Right-angled triangles offer yet another example. What happens if those who use haptic touch perceive the 90° angle as an angle in left triangles but as a curve in right triangles? He or she will draw upon the Pythagoras theorem in only half the cases where it is relevant – only with left triangles – and may fail fully to grasp the theorem.

The Pythagorean triangle (in which the black lines would be embossed):



(a) the actual
illustration
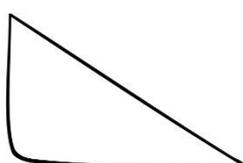
(b) how the illustration may be represented
if the 90° angle is perceived as a curve

**A mix-up of angles and curves has serious consequences:**
- **Lack of awareness of important, sometimes life-saving information**, especially among those who do not read braille due to low tactile sensibility (often caused by age, diabetes or stroke), dyslexia or not having learned braille properly. Ninety percent of all individuals who need braille do not read it well (BBC NEWS)
- **Miscommunication** between those using vision and those using haptic touch
- **Shortcomings in school**, e.g. in science and mathematics, where teaching relies on symbols and illustrations

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