

Public Perception Testing:

▀ Assessing the Ease and Speed of
Human Authentication

Prof. Jane Raymond



Secure • Perception • Research

■ User Confidence & Security Features

Public-level security features aim to enhance confidence by providing obvious signs of authenticity. These signs should be:

- Quick to locate
- Easy to interpret
- Impossible to duplicate

Security Feature Complexity



1790
Signature



1957
Image complexity
Colour
2-sided



1990's
Visible metal
thread



2000's
image changing
foil patch



2010's
Windows,
Colour & image change
Multiple security features,
front and back.

Outline

Part 1: Human Authentication

- The split-second time frame of authentication
- Perceptual and cognitive steps in authentication.

Part 2: Research on Security Feature Design.

- Impact of design complexity
- Using colour to enhance visual effects

Part 1: Human Authentication



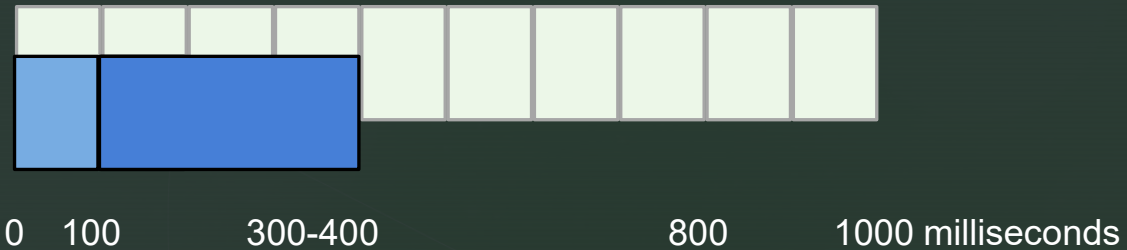
A slow motion view of a cash transaction.

The customer (left) views the note for 1 second.

What can you see in one second?



Visual processing in a split second



- 1/10 of a second to analyse a visual scene.
- About 1/3 of a second to consciously recognise an object.

Your brain takes just under $\frac{1}{2}$ second to recognise something that you looked at for only a tenth of a second .

Eye movements and seeing

The green circle indicates gaze.

Rapid eye movements (saccades) are alternated with stationary gaze (fixations).

Fixations are brief, between 100 and 300 ms

We can only “see” during a fixation.



Eye movements during authentication



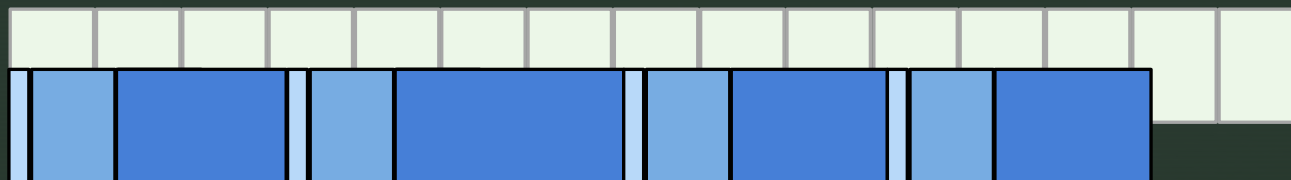
1. Users typically make 2-4 eye movements prior to authentication.
2. First, an orienting eye movement is made, usually to the middle of the banknote.
3. Then the eye is automatically directed toward the most interesting feature.
4. Successive eye movements are directed toward useful information.

Time after banknote appears →

0

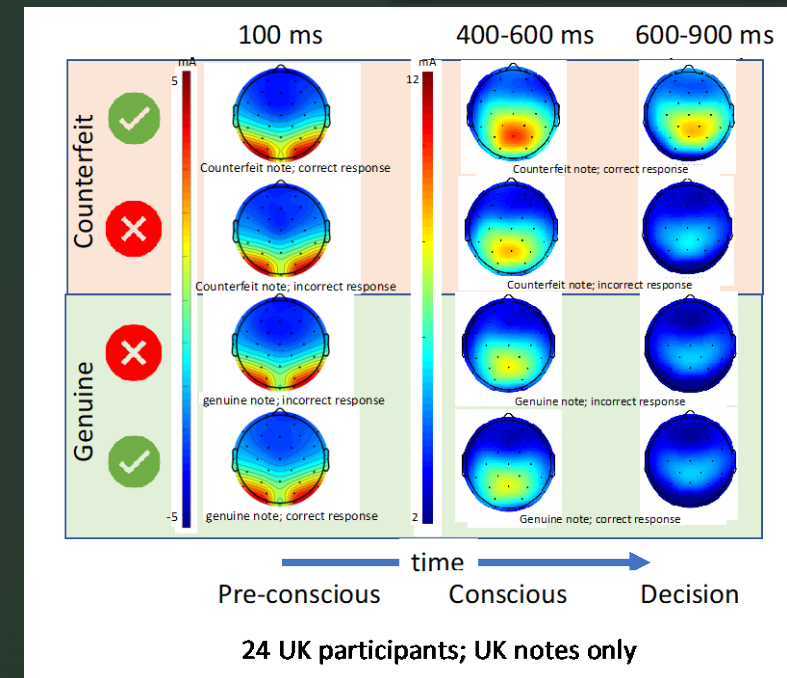
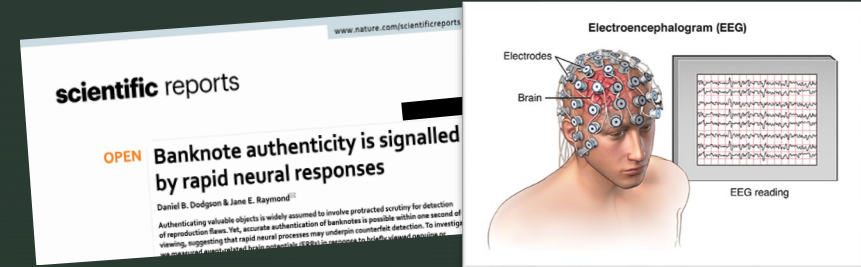
500

1000



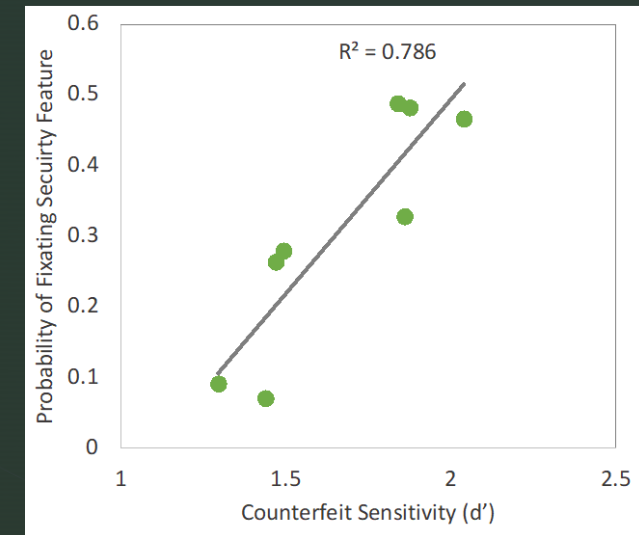
The Science of Fast Authentication

1. Visual signs of counterfeit are fully registered by the brain within $\frac{1}{2}$ second.
2. Authentication is made within $\frac{1}{2}$ - $1\frac{1}{2}$ seconds of seeing a banknote. Longer looking does not improve authentication.



The Science of Fast Authentication

1. Visual signs of counterfeit are fully registered by the brain within $\frac{1}{2}$ second.
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3. Looking at a security feature within the first second determines successful authentication.



SCIENTIFIC REPORTS

OPEN Strategic Eye Movements are Used to Support Object Authentication

Jane E. Raymond¹ & Scott P. Jones²

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Authentication Steps

Time after banknote appears →

0



Authentication Time

Time to
find security
feature

**Fixation
Time**

Time to
process the
security
feature

**Seeing
Time**

More time
on security
feature

**Checking
Time**

Authentication Steps

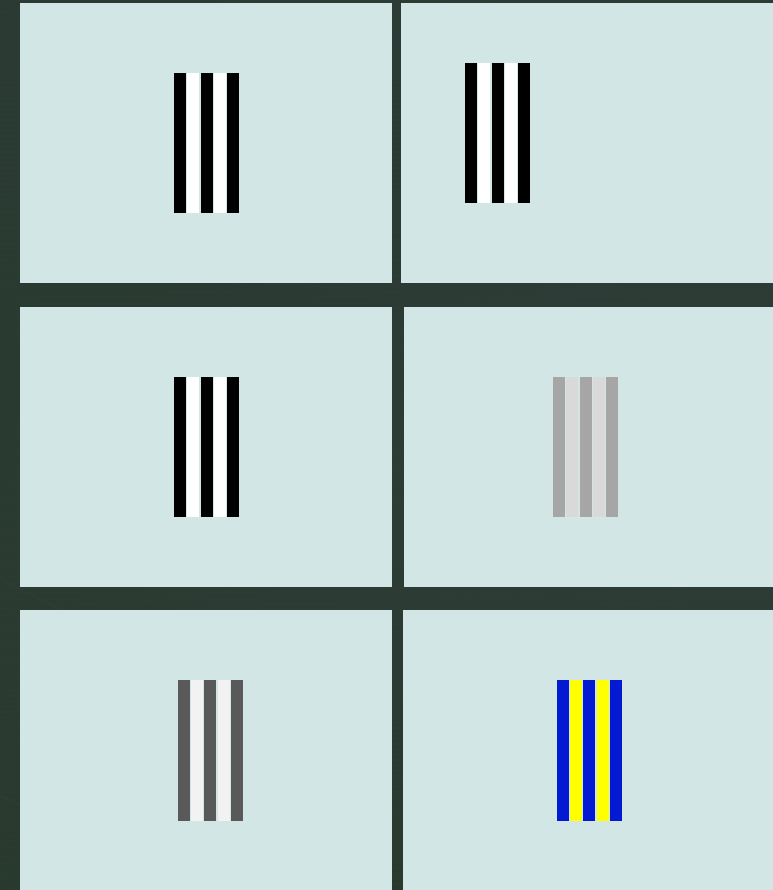
1. Find the security feature
2. Recognise it's visual effect
3. Check, if needed
4. Make a response

Factors affecting Fixation Time

The brain automatically directs gaze to salient information:

- Movement
- High brightness contrast
- High colour contrast
- Sharp high resolution edges

Desirable properties
of security features



Factors Affecting Seeing & Checking Time

Visual recognition of visual effects is eased by

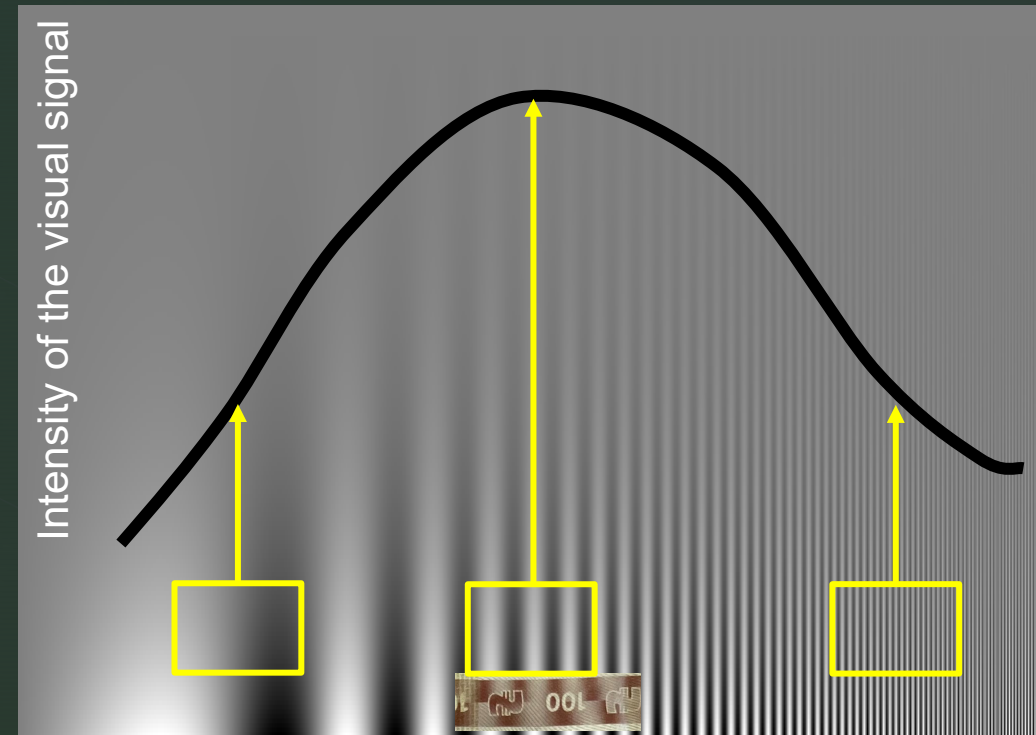
- Simplicity
- Intense visual signals
- Optimized for human vision



Factors Affecting Seeing Time

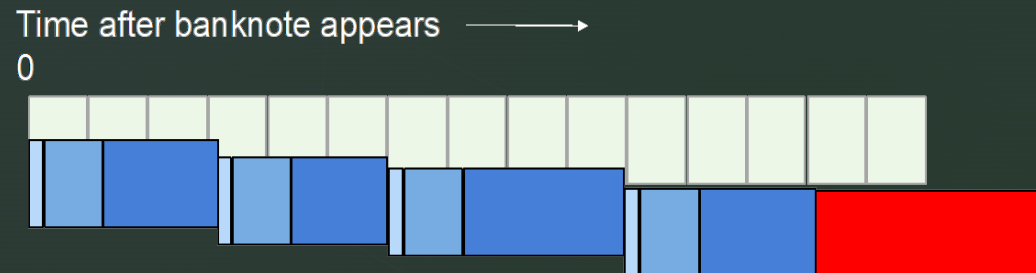
Visual recognition of visual effects is eased by

- Simplicity
 - Intense visual signal
 - Optimized for human vision
- Sensitivity to contrast varies with line width and movement speed.
 - Medium-sized patterns at optimal speed provide an intense visual signal to the brain.
 - Visual effect in RAPID® is optimal for delivering an intense visual signal.



Summary so far...

1. Authentication is fast perceptual process



2. Authentication is stepwise

Authentication Steps

1. Find the security feature
2. Recognise its visual effect
3. Check, if needed
4. Make a response

3. Security Features should provide:

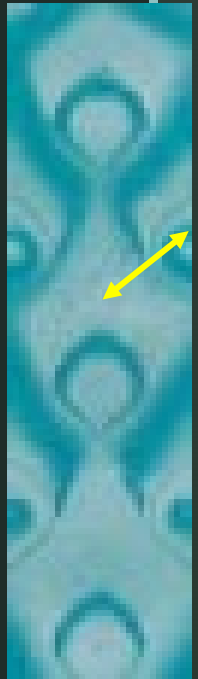
Movement
High brightness contrast
High colour contrast
Sharp, high resolution edges

Simplicity
Intense visual signal
Optimized for human vision

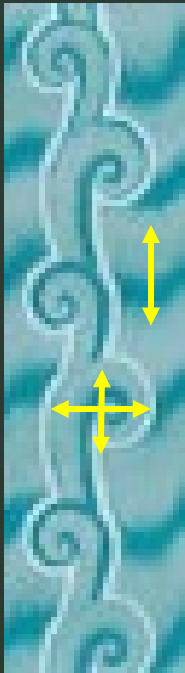
Part 2: Research on Security Feature Design

Aim: Assess new designs of RAPID[®]

- Impact of design complexity
- Using colour to enhance visual effects



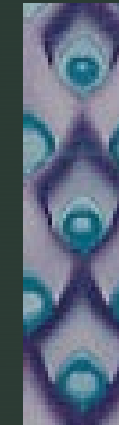
One visual effect



Two visual effect



1
colour



2
colours

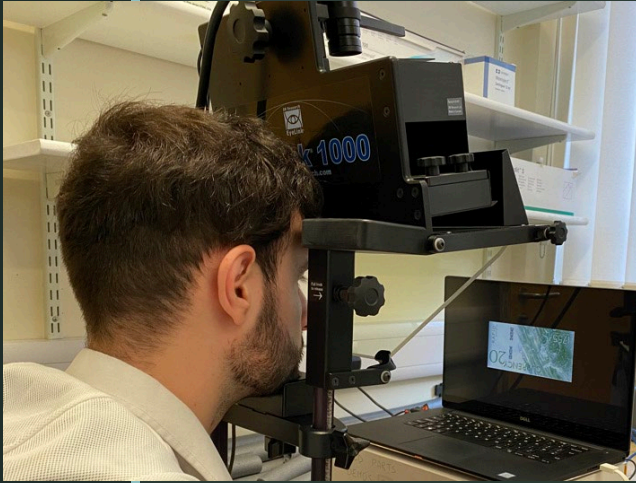


1
colour



2
colours

Research Methods



Procedure: Three Phases

1. **Handling** physical banknote samples (familiarisation)
2. **Authentication task** with eye monitoring.
3. **Subjective choice** task: Which is easier to use?



22 adults
(21-56 years old)

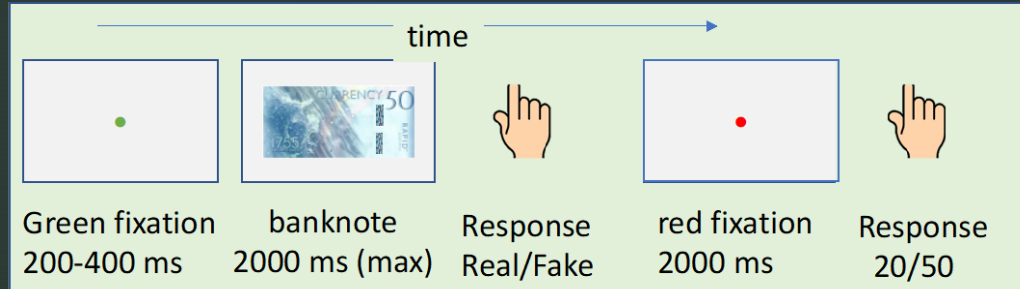
Research Methods



Test Materials: RAPID[®] threads

- Same background on all samples.
- Two denominations.
- Genuine RAPID[®] threads or
- Simulated threads ('counterfeit').

The authentication task



- A randomly ordered series of banknote samples is presented.
 - 1/3 counterfeit
 - 36 per thread variation
 - 1/2 are inverted.
- Judge authenticity as quickly and accurately as possible.
- Report denomination.
- Eye movements are measured on each trial.



A few sample trials

Real or Fake? What denomination?



- An aggregated visualisation (actual speed)

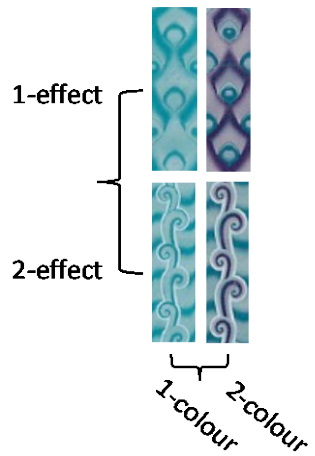


- An aggregated visualisation 10% speed



Study Design

Critical comparisons



Main comparisons:

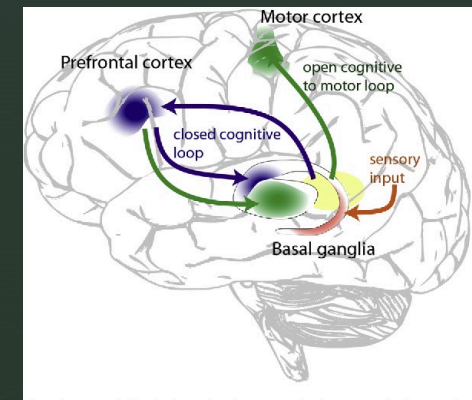
- Design complexity
 - 1 effect v. 2 effects
- Colour complexity
 - 1 colour v. 2 colours

Eye movement measures

1. Fixation Time: Time to 1st fixation to thread
2. Seeing Time: Length of 1st fixation of thread
3. Checking: Total additional time on thread
4. Action+: Denomination plus response

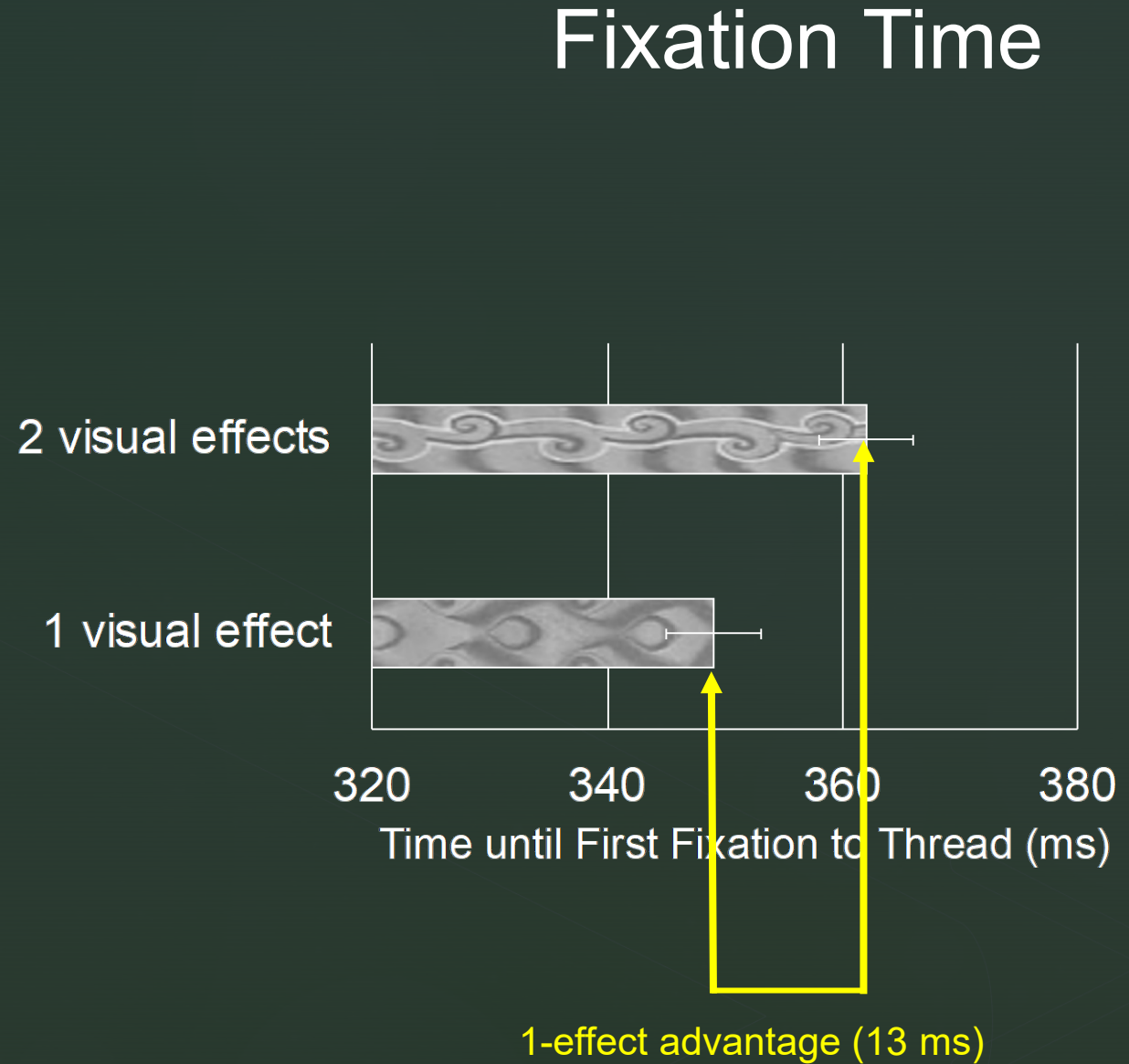
Millisecond (ms) timing

- The brain circulates information in rapid loops, taking 10-20 ms each.
- Processing depends on exquisite synchrony, in the 10 ms range.
- 20-50 ms slowing increases perceived mental effort.



Gaze capture is modestly faster for the simple design.

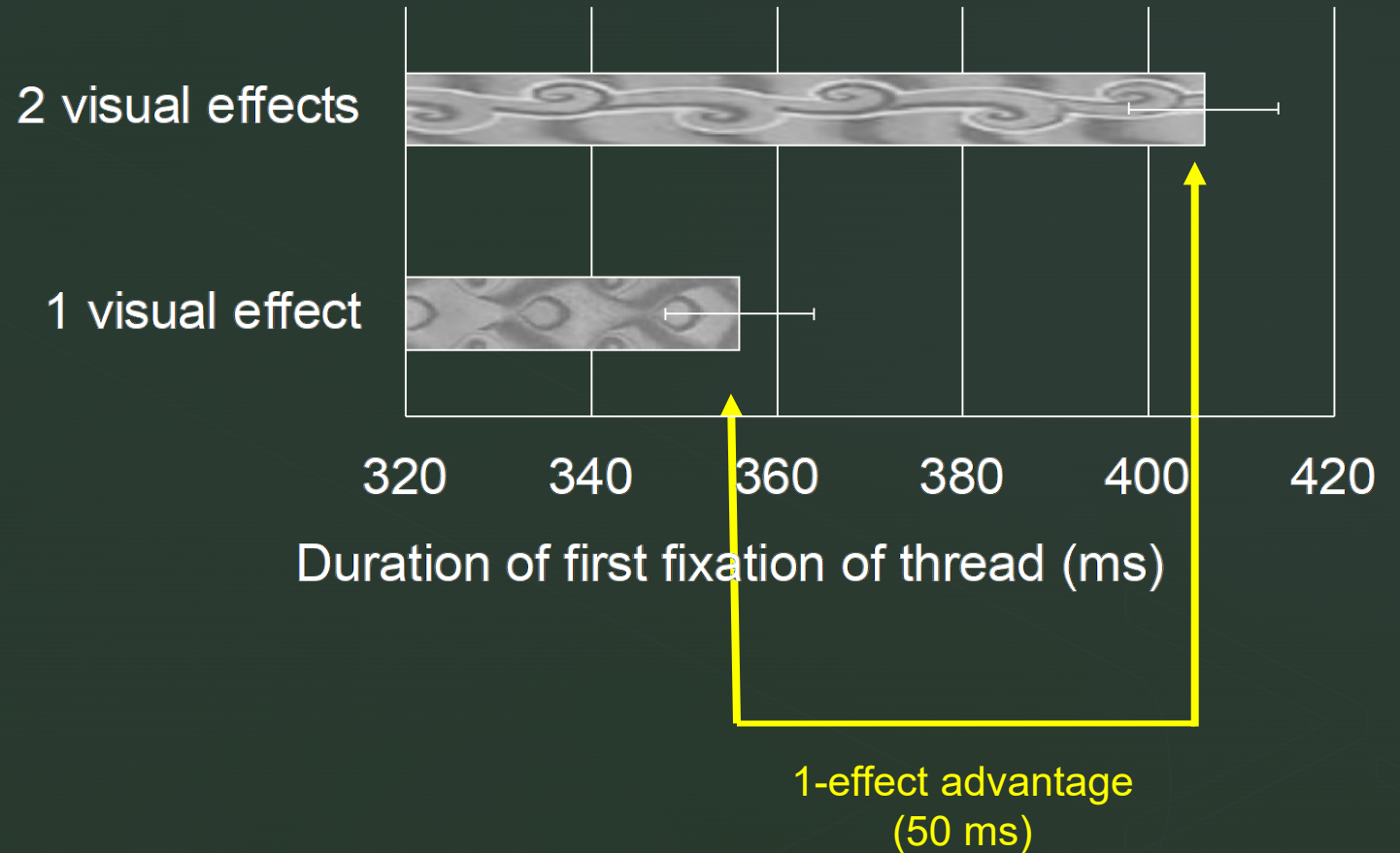
Fixation of the security thread typically occurs on the very first eye movement after orienting to the centre.



Simplicity speeds interpretation of the visual effect.

The threads simple movement can be accurately recognised in 0.7 s.

Seeing Time

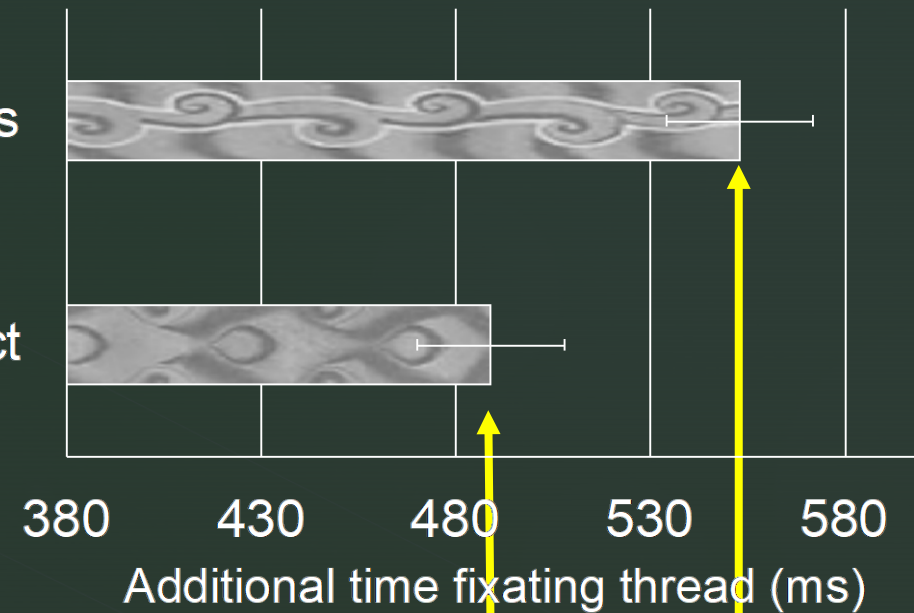


Less checking is needed with a simple design, saving 64 ms of time.

This indicates that confidence is higher with a simple design.

2 visual effects

1 visual effect

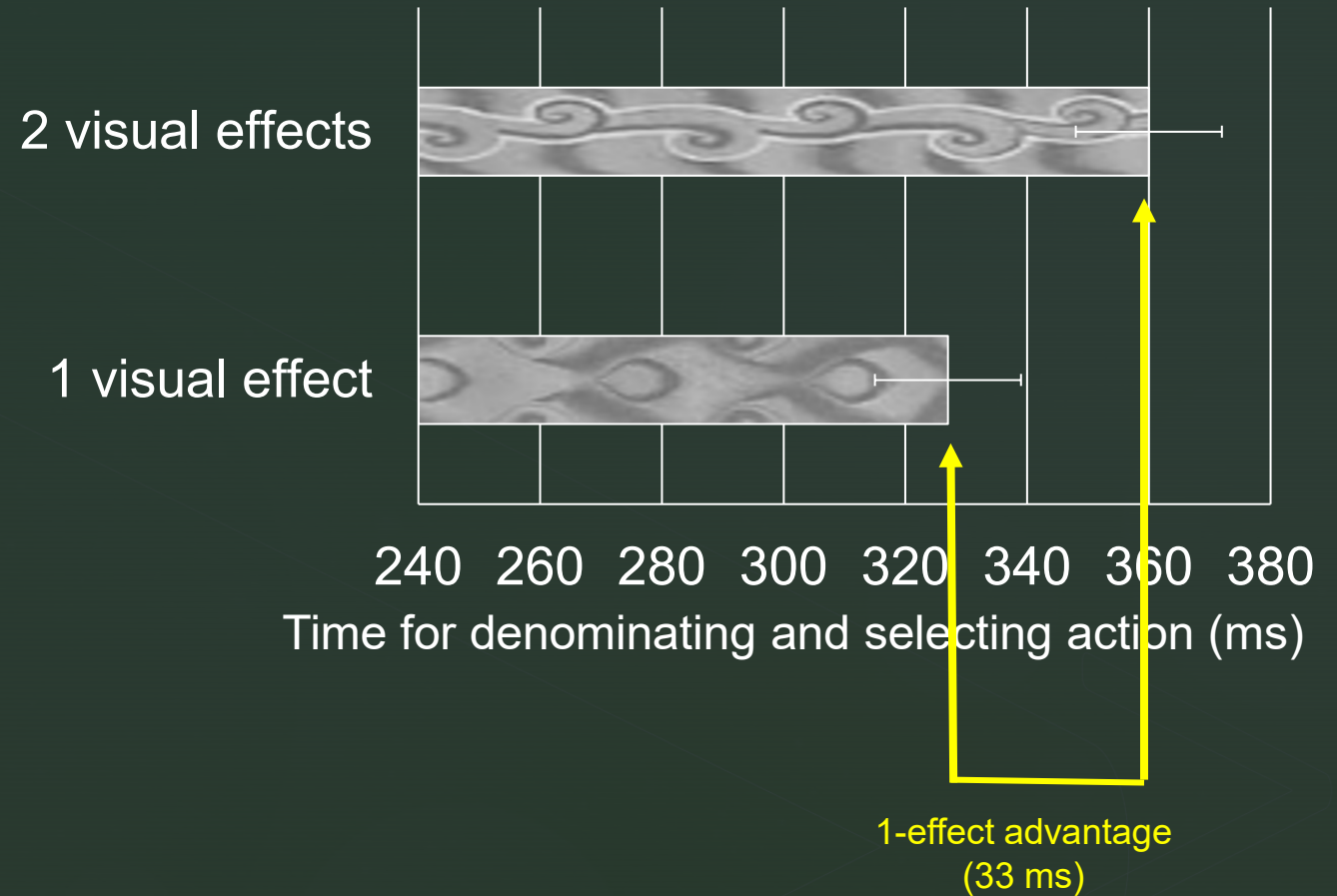


1-effect advantage
(64 ms)

Checking Time

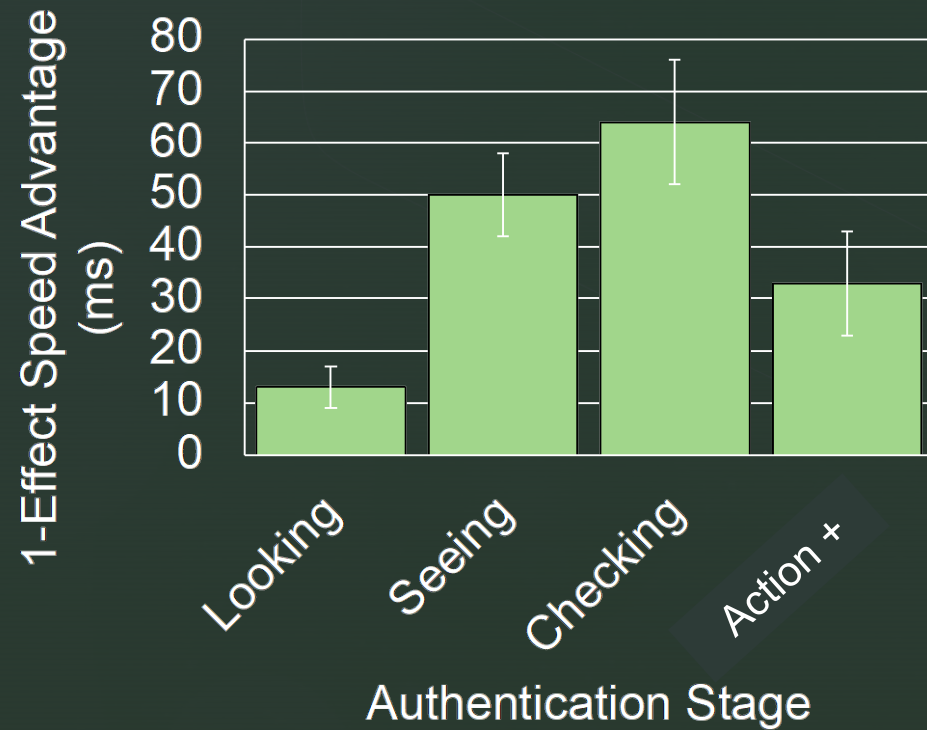
Simple designs lower cognitive load, speeding denominating and action.

Action+ Time



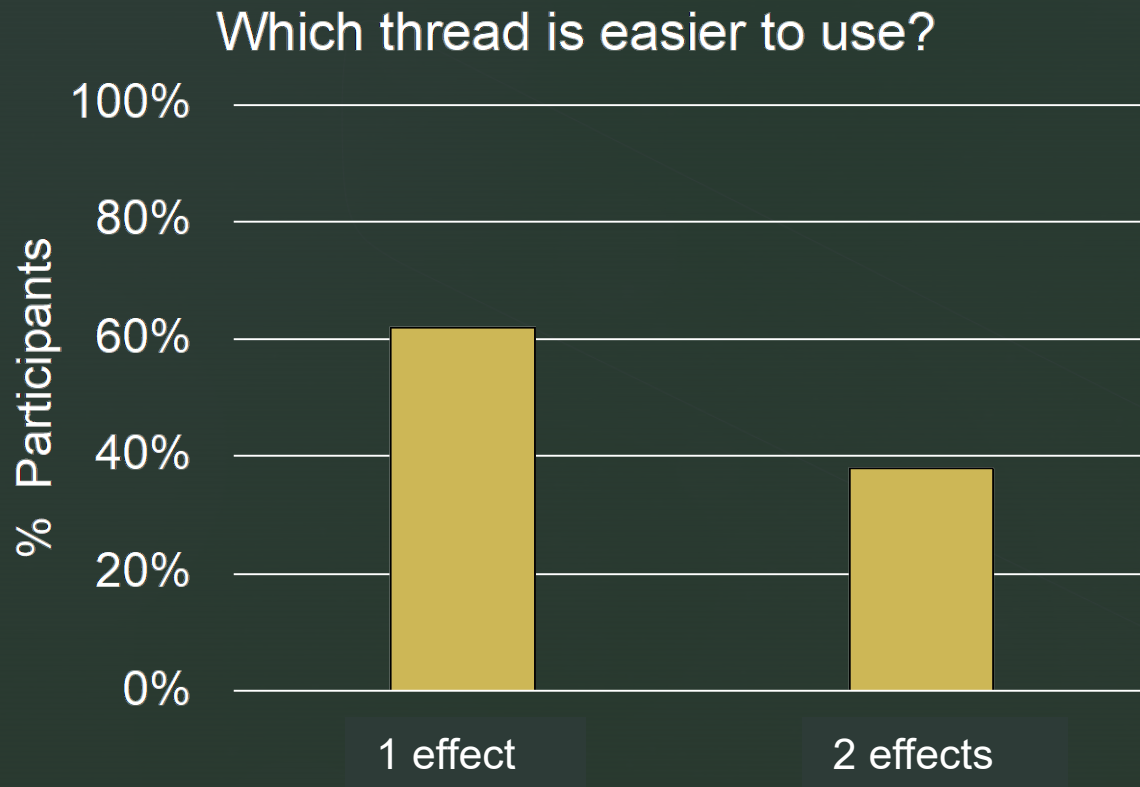
1 effect v. 2 effects

Summary of 1-effect design advantages.



- Speed of authentication is 160 ms faster with a 2-effect thread.
- Accuracy with simple design was slightly better (94% v. 91%).

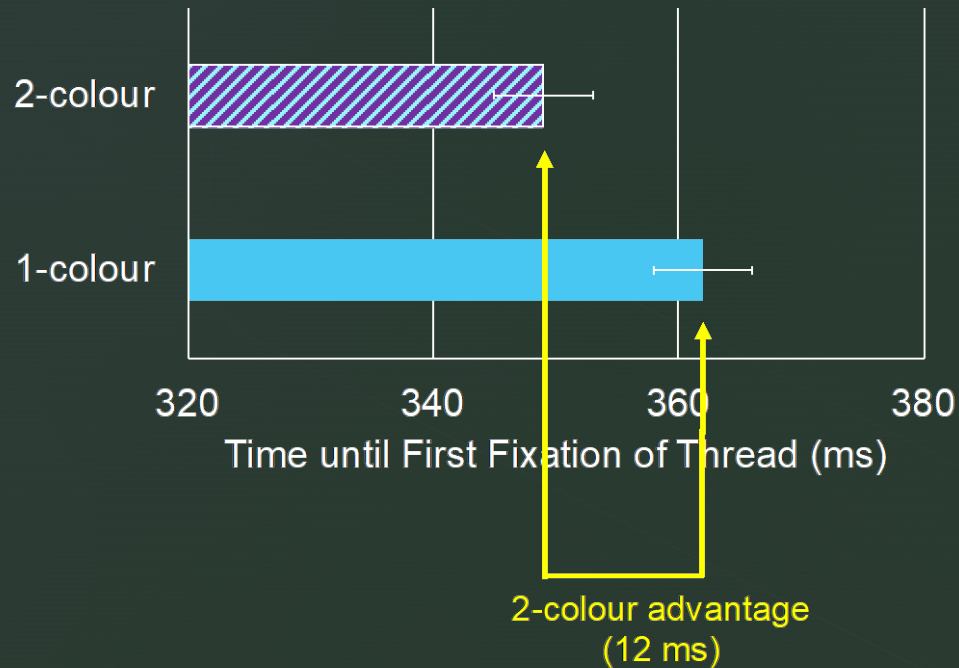
1 effect v. 2 effects



Subjective preference choice based on ease of use show clear preference for 1-effect thread.

Fast authentication is perceived as “easy to use”.

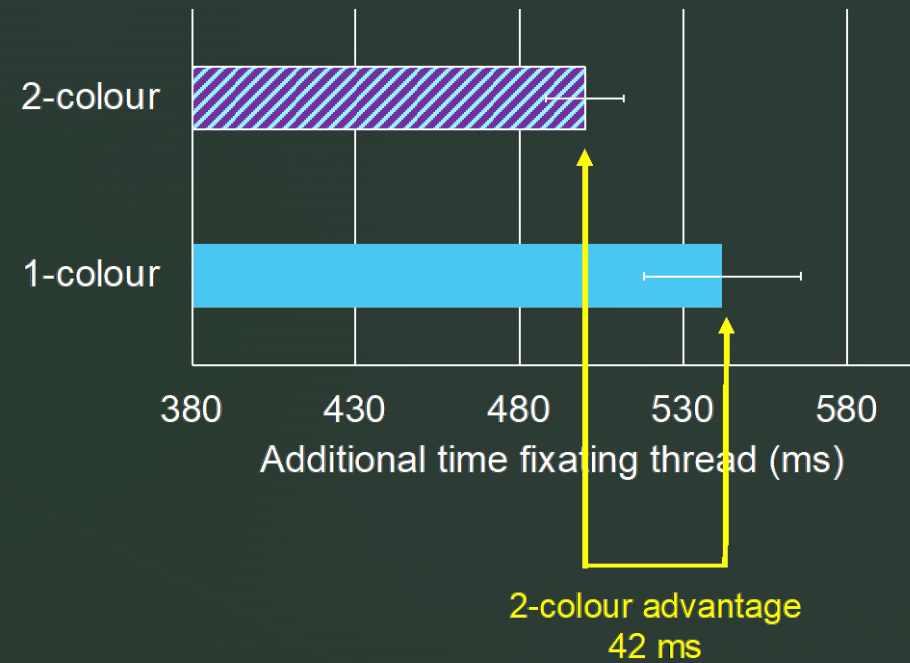
Fixation Time



Seeing Time: No effect of colour

Action+ Time: No effect of colour

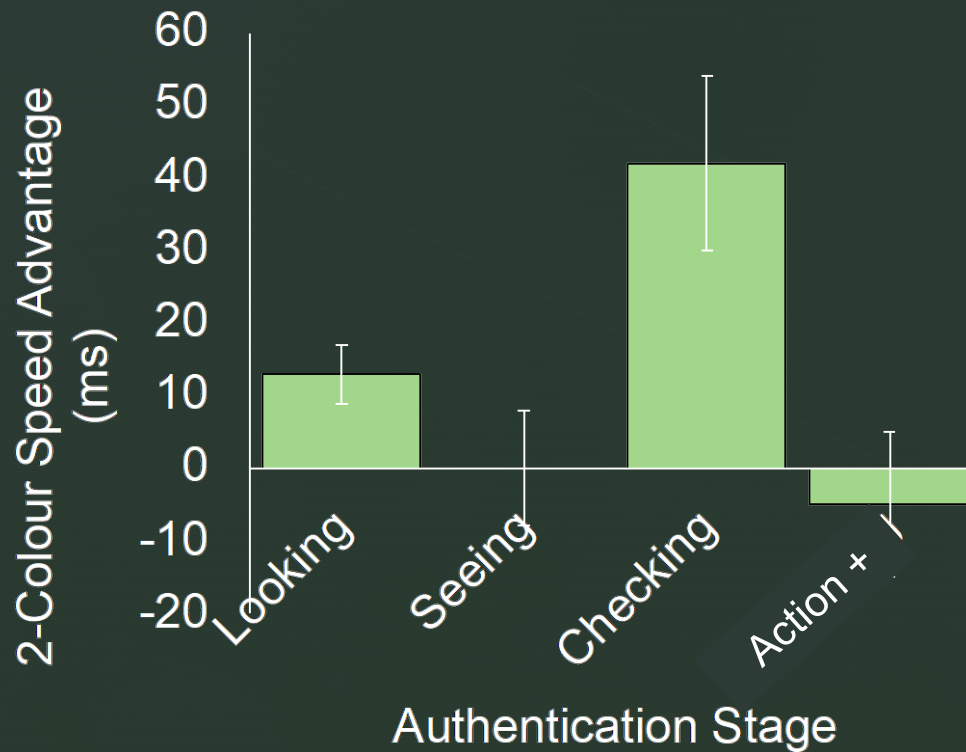
Checking Time



Using a second colour in the thread provides a stronger signal. This speeds fixation time and enhances perceptual certainty.

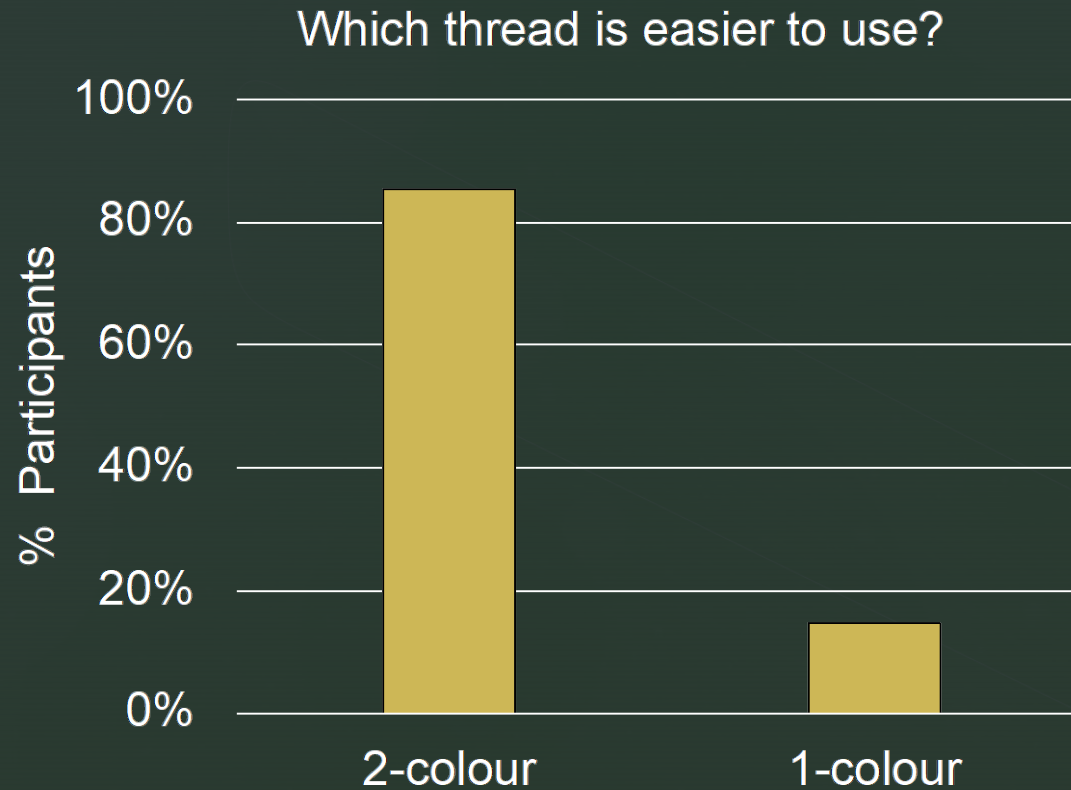
1-colour v. 2-colour

Summary of 2-colour advantages.



- Speed of authentication is 50 ms faster with a 2-colour thread.
- No effect on accuracy (92%, both).

1-colour v. 2-colour



Subjective preference choice based on ease of use show clear preference for the 2-colour thread.

Faster authentication is perceived as “easy of use”.

Research summary

Design Complexity.

- All steps in authentication are faster when the visual effect in the security thread is simple.
- The speed of responding is faster for 1-effect designs by almost 1/5 of a second.
- Accuracy is modestly higher for 1-effect designs.
- Participants find simple 1-effect design easier to use.

Keep it simple!

Research Summary

Colour Complexity.

- Fixation and checking are faster with 2-colour threads indicating that boosting contrast in the security thread speeds these steps in authentication.
- Authentication speed is faster for 2-colour threads by 50 ms.
- Accuracy is unaffected by colour.
- Participants find the 2-colour threads easier to use.

Two-colours are better than one!

Recap & Conclusions

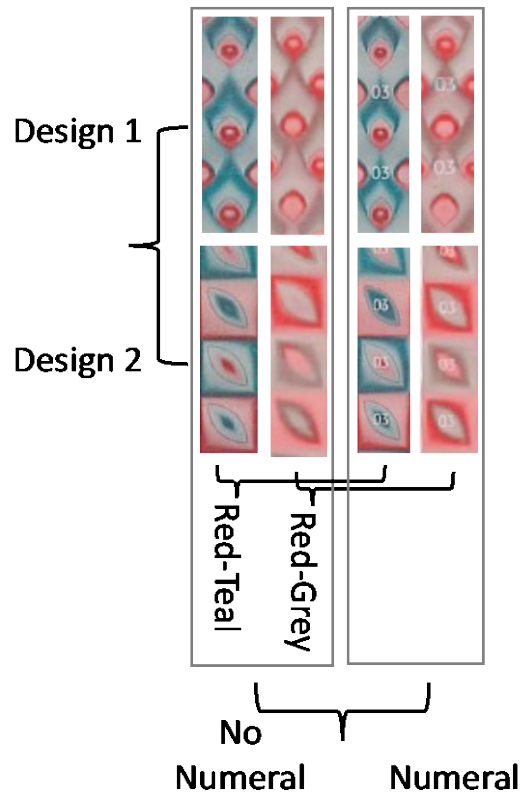
- Fast, easy authentication can boost confidence in banknotes.
- Authentication involves 4 steps: Fixation, Seeing, Checking, Action.
- A good security feature should
 - Capture gaze rapidly and automatically.
 - Provide a simple, easy to interpret visual sign of authenticity.
- A security feature's visual effect should be simple and intense.



Thank you for your attention!

Follow up questions

Critical comparisons



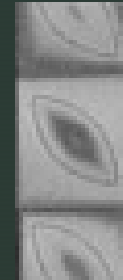
1. Does the pattern make a difference?
 - Would a changing checkerboard be as effective as the "Fireball" design?
2. Is colour combinations important?
 - Would Red-Teal or Red-Grey combinations also be effective?
3. Does the presence of a small numeral on the thread impair perception?



Effect of design?



Fireball

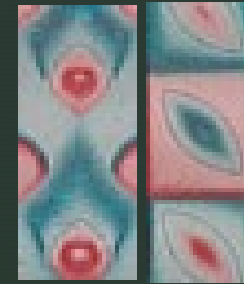


Checkerboard

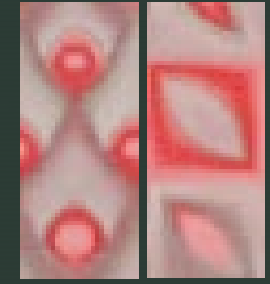
Pattern has no effect on any authentication step.

Behavioural speed and accuracy are similar.

Colour combination?



Red -Teal



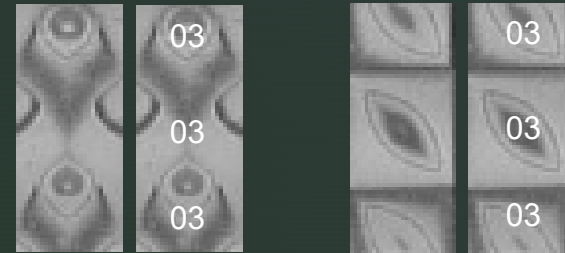
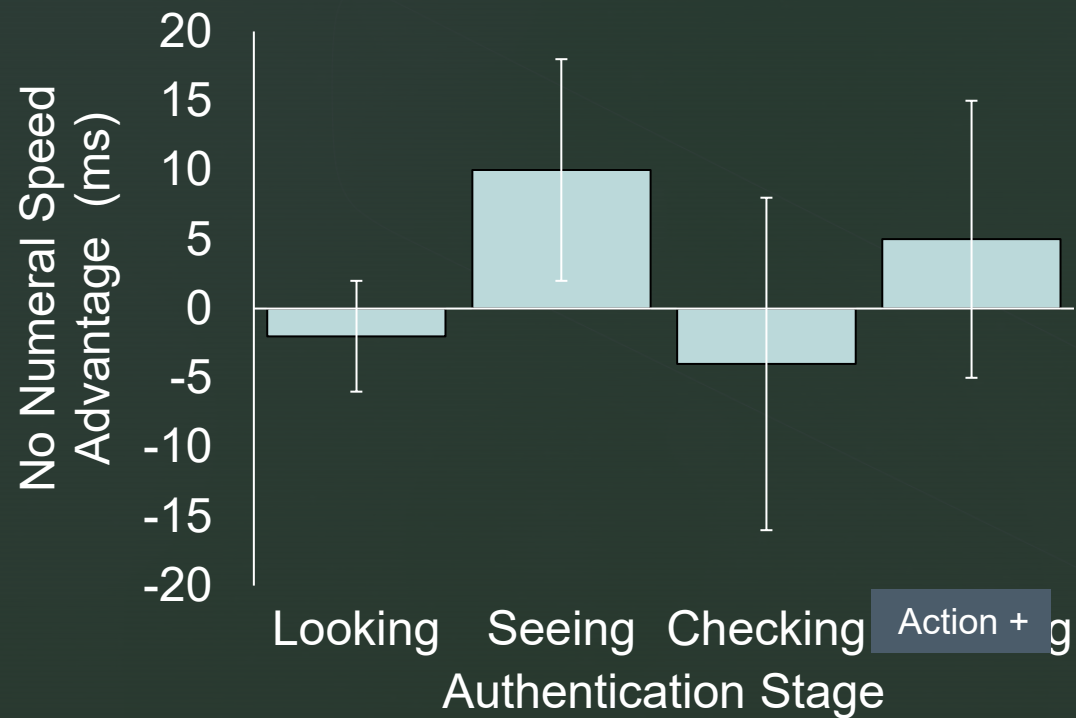
Red-Grey

Red-Teal speeds Seeing and Action+ .

Behavioural response is 60 ms faster with Red-Teal

Likely due to higher contrast for red-teal.

Effect of a numeral?



Numeral has no effect.