Using Forced-Journey Choice Methodology to Investigate the Usability of Octolinear Versus Concentric Circles Maps

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Plan of the Paper

- Concentric circles maps

- The usability gap

- A forced-journey choice experiment

  - Method

  - Results

- Discussion and conclusions

Concentric Circles Maps

- Highly constrained design rules

    - Circles and arcs, all centred on central point

    - Straight lines, all radiating from central point

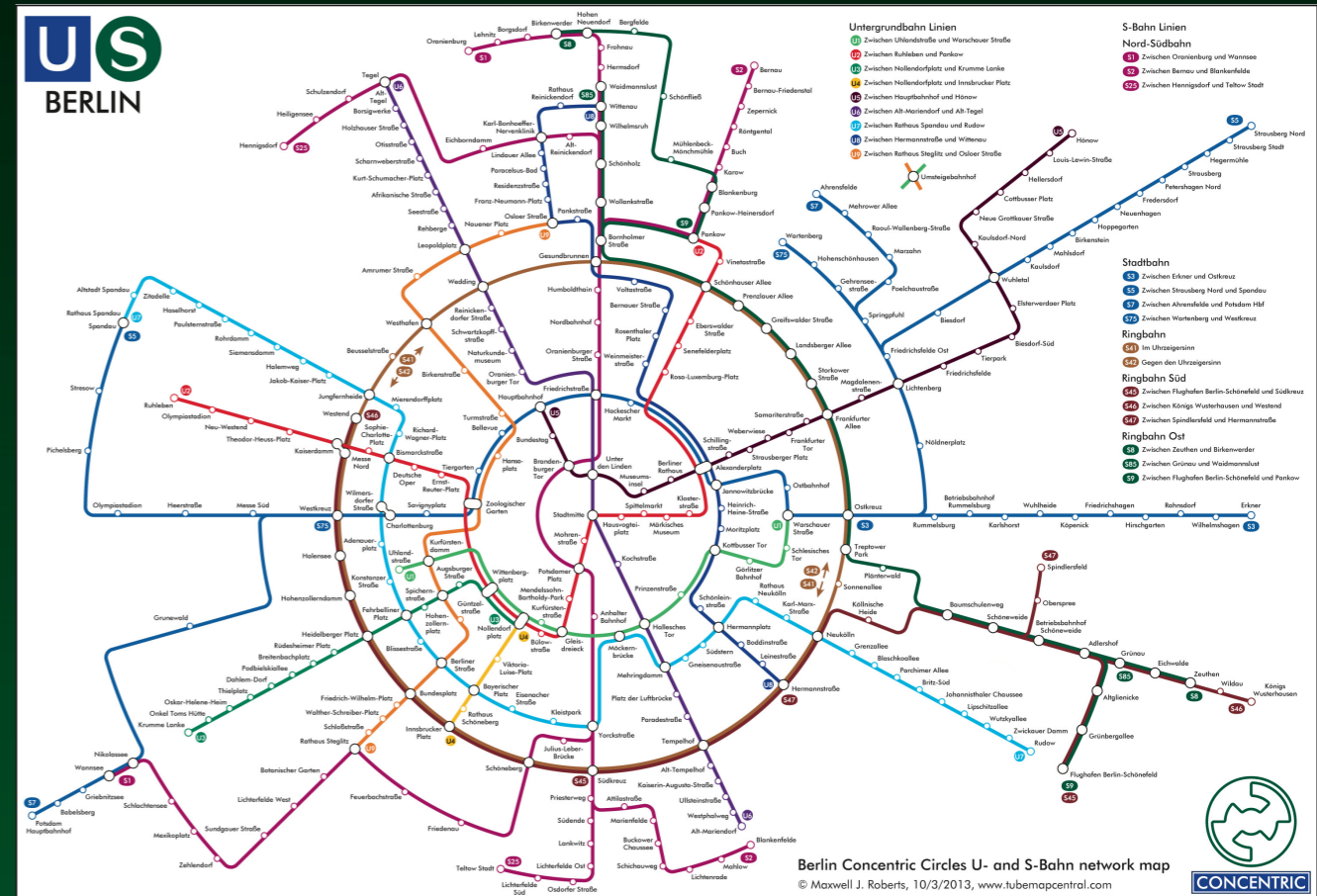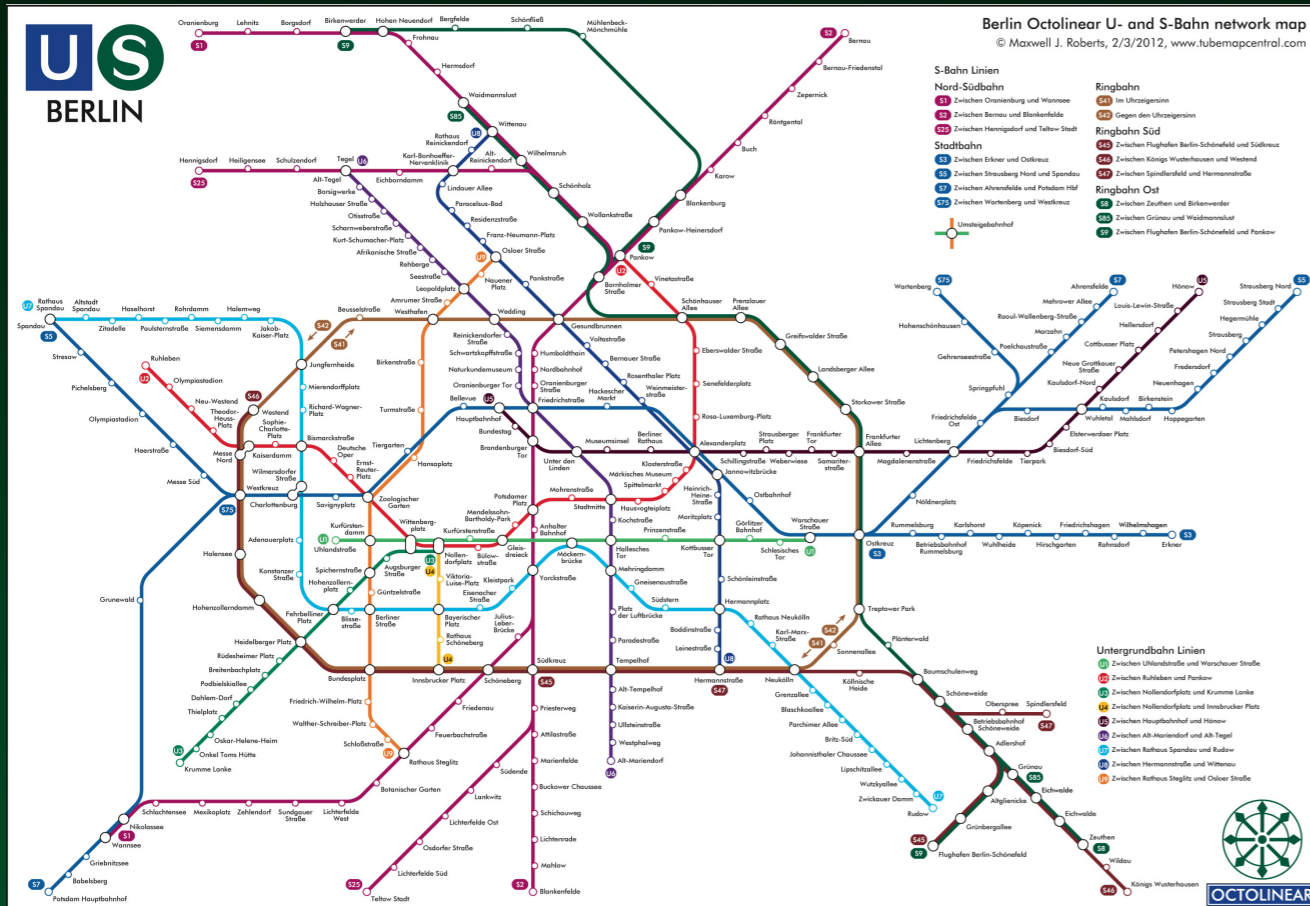- Powerful images, generate considerable interest
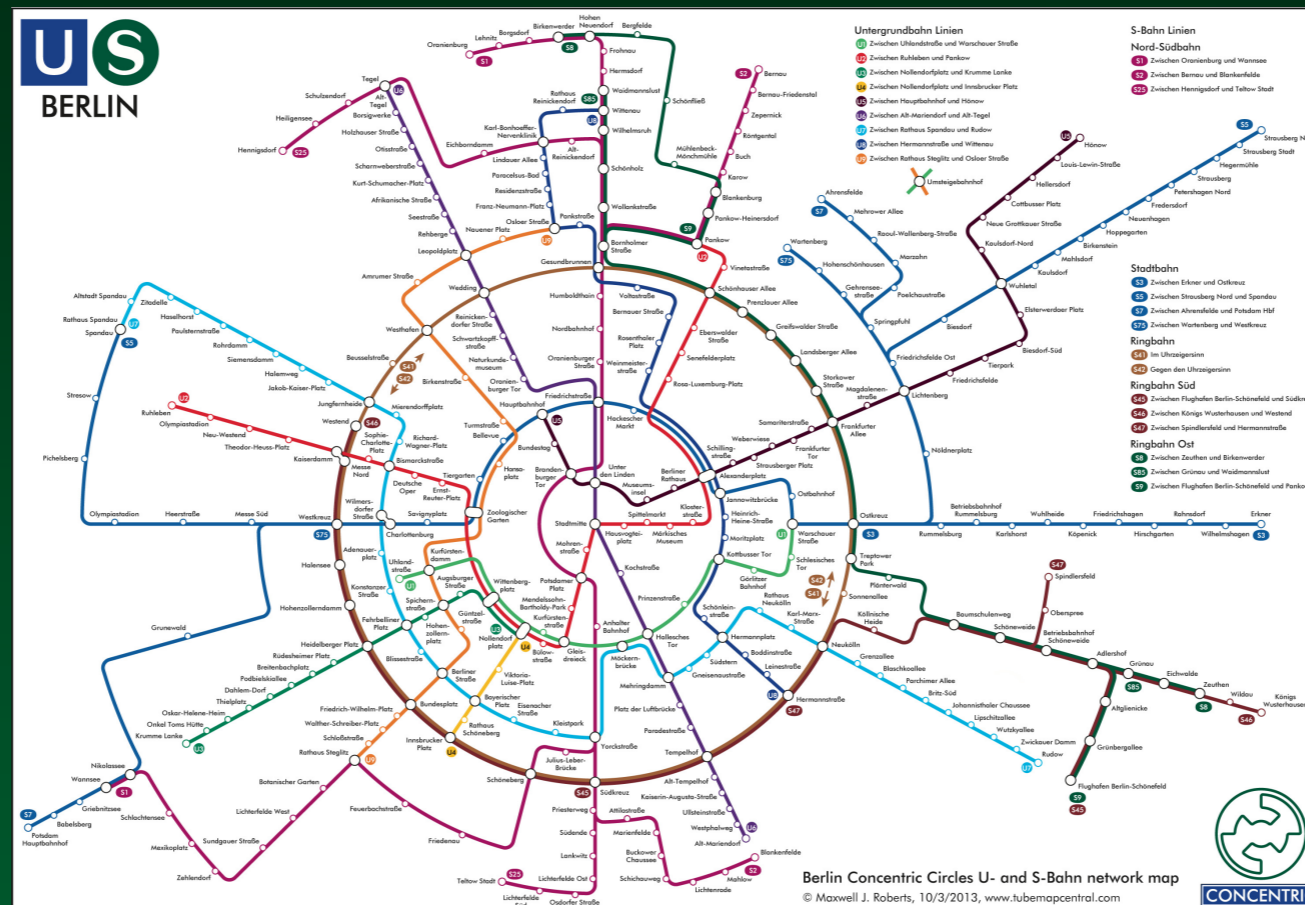
Concentric Circles Maps

- Framework for Effective Design

  - *Simplicity:* individual line trajectories should have minimal changes of direction

  - *Coherence:* lines should relate to each other to give an orderly design with good shape

    - symmetry

    - equidistance (grid)

    - parallelism

    - alignment

Concentric Circles Maps

- Concentric circles maps versus octolinear: interesting properties

Berlin Octolinear U- and S-Bahn network map
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Berlin Concentric Circles U- and S-Bahn network map
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- Better simplicity
- Worse coherence

- Worse simplicity
- Better coherence

Concentric Circles Maps

- Roberts, Newton & Canals (2016)

  - Compared concentric circles and octolinear maps of Berlin

  - N = 40, within-subjects

  - **Planning task:** twelve complex cross-city journeys

  - Objective measures: Mean times to plan journeys and estimated journey durations

  - **Questionnaire:** maps evaluated by various criteria

  - Subjective measures: Simple preferences and aggregate statement rating task scores

Concentric Circles Maps

- Roberts, Newton & Canals (2016)

  - Concentric circles map *slow* and *unpopular*

  - Simplicity should take priority over coherence
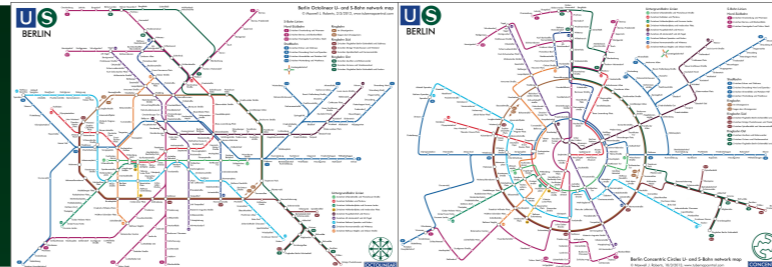
Planning Time Seconds	25.2	30.9	$p < 0.01$
Est Journey Duration Minutes	62.5	62.4	$p > 0.05$
Aggregate Rating (Range 11 to 55, mid = 33)	44.4	33.7	$p < 0.01$

The Usability Gap

- Poor association between objective versus subjective evaluations of usability

  - RNC (2016): measures *aligned* not *associated*

- Might lead to objectively usable maps being rejected

- Journey planning times a convenient measure but low *psychological utility*

- Bridge usability gap by identifying usability measures with *high* psychological utility

  - RNC (2016): *concentric circles maps make every journey look roundabout, hard to identify efficient ones from alternatives*

The Usability Gap

- Roberts (2019)

  - RNC (2016) comments and data suggest investigation of forced-journey choice task

    - Slower decision times for concentric circles maps?

    - Clear consensus of route preference less frequent for concentric circles map trials?

  - Usability gap is bridged?

Forced-Journey Choice Experiment

- Method

  - Compared concentric circles and octolinear maps of Berlin

  - N = 60, within-subjects

  - **Journey choice task:** 24 trials, each with two pre-determined options, range of difficulty

  - Objective measures: Mean decision times and journey selections

  - **Questionnaire:** maps evaluated by various criteria

  - Subjective measures: Simple preference and aggregate statement rating task scores

Forced-Journey Choice Experiment

- Results
  - Concentric circles *unpopular* but not *confusing*
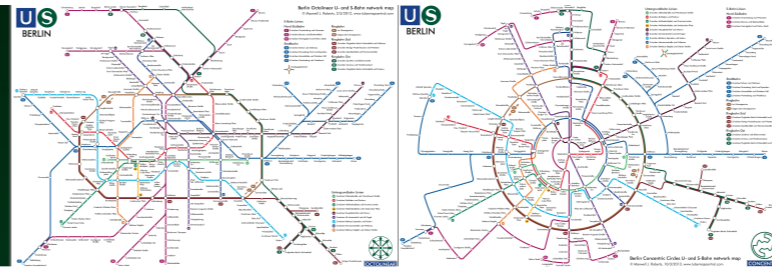
Decision Time Seconds	9.7	9.4	$p > 0.05$
No Clear Consensus Majority ≤ 70%, No. Trials/24	7	5	
Aggregate Rating (Range 20 to 100, mid = 60)	74.8	68.2	$p < 0.01$

Forced-Journey Choice Experiment

- Results (summary)

    - Route choice is a valid measure of prevarication: ignoring map, high vs low trials differ in times, $p < .05$

    - No significant difference in decision times between maps, concentric circles not inherently harder

    - Concentric circles map unpopular: significantly lower rating scores but smaller effect than RNC (2017)

    - Many trials showed interesting differences between maps in journey preference

Route A: 100%
Length +
Directness +
Simplicity +
Station count +

Route A: 69%
Length 0
Directness +
Simplicity +
Station count +

Forced-Journey Choice Experiment

- Results (summary)

  - Many trials showed interesting differences between maps in journey preference

Route A: 100%
Length +
Directness +
Simplicity +
Station count +

Route A: 69%
Length 0
Directness +
Simplicity +
Station count +

Discussion and Conclusions

- Route choice amongst competing options is not inherently difficult for concentric circles maps

  - Goes against prediction made on basis of subject reports in RNC (2017)

- Concentric circles maps unpopular but less so compared with RNC (2017)

  - Journey planning (plus journey choice) ⇒ time decrement and strong unpopularity

  - Journey choice only ⇒ no time decrement and mild unpopularity

Discussion and Conclusions

- Difficulty with concentric circles maps is is assembling journeys owing to complexity of line trajectories:

    - Either, assembling journeys is difficult, extra planning time needed

    - Or, journeys assembled easily but lack *plausibility* prompts search for alternatives, adds planning time

- Leads to a different emphasis in use

    - Octolinear maps:
    journey planning = search for a good option

    - Concentric circles maps:
    journey planning = search for the least bad option