

Estimating Imagined Colors from Different Music Genres with Eye-Tracking

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Background

- Colors & Music can convey emotions with their genres without acquired learning
- Studies of linking color & music at human cognition gained widespread attention
 - Help understanding human feelings
 - Provide references to multimedia applications (games, concert live shows, etc.)

Issues

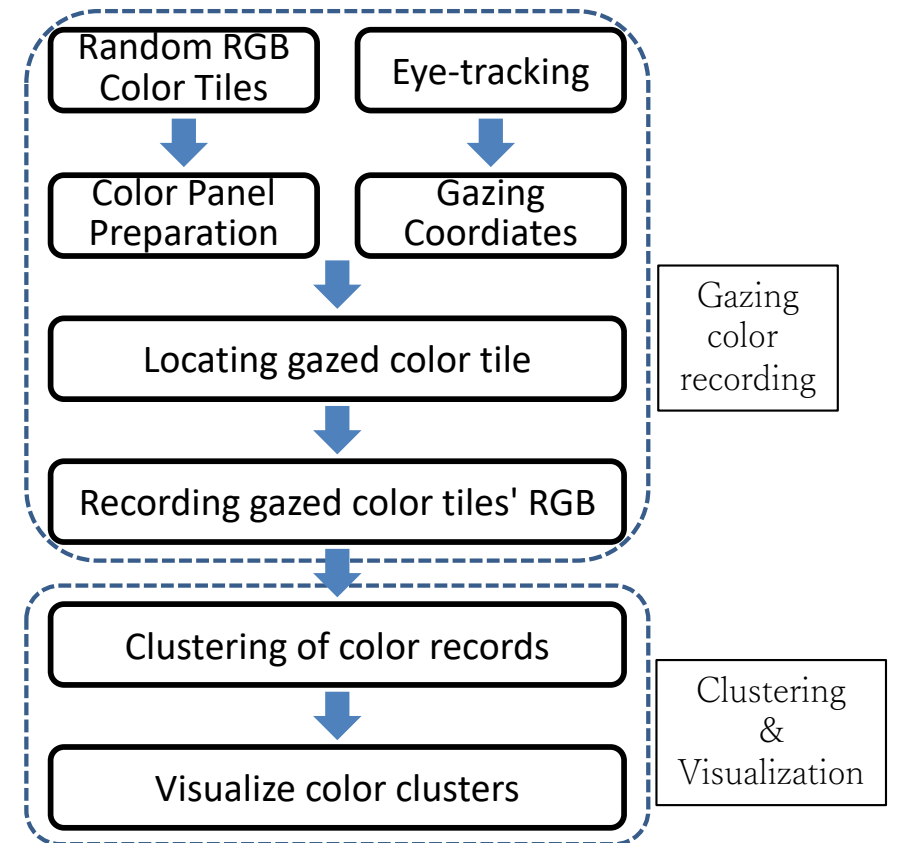
- Past studies require specialized knowledge or skills
 - signal processing, music theory
 - absolute pitch, etc.
- Hard to understand & cross-compare results from different methods

Contributions

1. Record & estimate users' imagined colors with eye-tracking device and clustering method without involving complex theories or processings
 - record users' gazed colors via eye-tracking
 - cluster color categories from gazed color record
2. Measured corresponding colors to six genres of music with the proposed system through participant experiments.
 - Rock, Ballad, and Pop, each with male- and female- vocals.

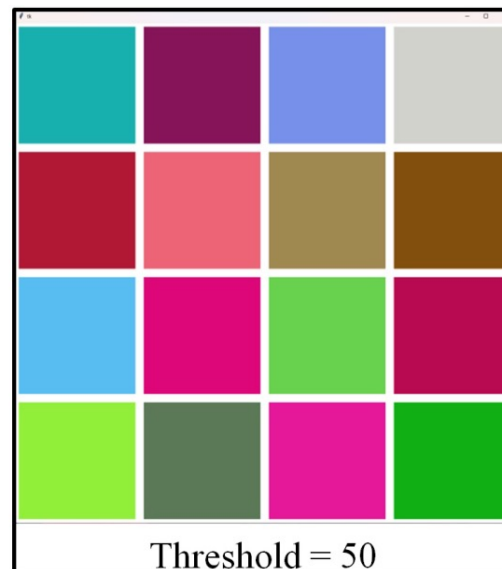
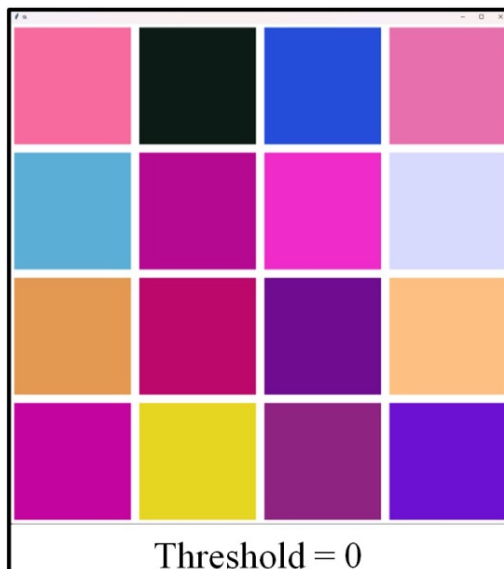
System Flow

- Gazing color recording via eye-tracking
 - Random colors generation & color tiles location
 - Eye-tracking to get the gazed color tile
 - Recording RGB values of gazed color tiles
- Clustering & visualization of gazed color records
 - Split gazed color records to main clusters (color categories)



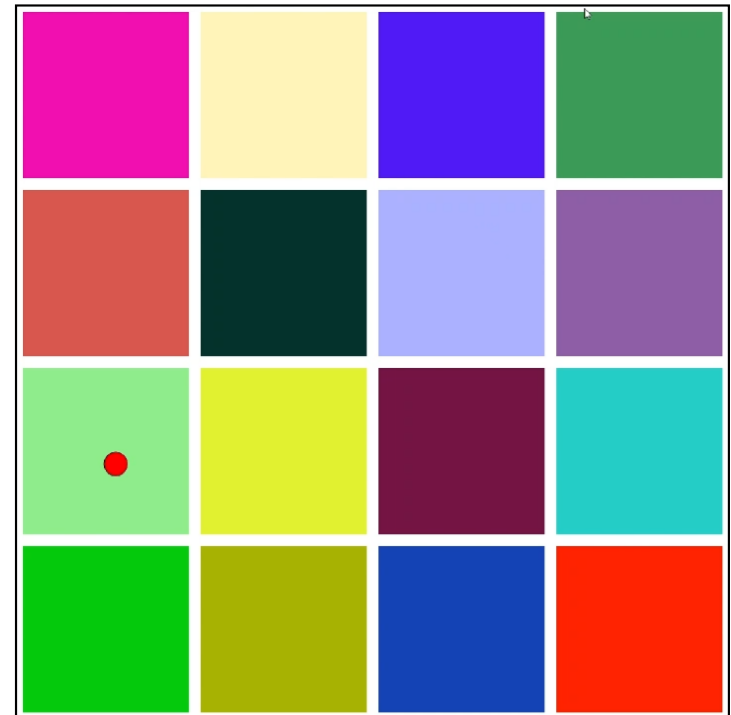
Random Color Tiles Preparation

- Random 16 colors on a 4×4 color panel
- Each two of the 16 colors follows:
 $|R_i - R_j| + |G_i - G_j| + |B_i - B_j| \geq \text{Threshold}$ ($i, j \in 16$ colors)
- Record coordinates along with the RGB values
- Refresh every 2.5 seconds
 - 0.5 seconds for reaction & 2.0 seconds for recording



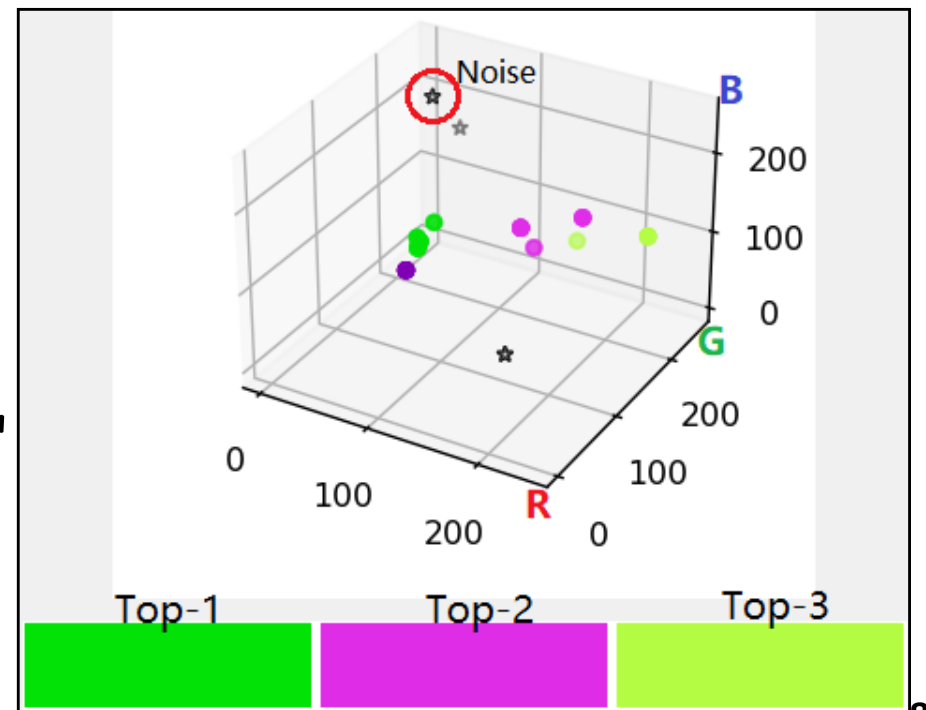
Gazing Color Recording via Eye-tracking

- Eye-tracking via "Tobii Pro Nano"
 - Get gazing coordinates within the screen of the left & right eyes, respectively
- Calculate the "midpoint" of the left & right eye's gazing coordinates as the "gazing point"
- Record the color tile's current RGB value to list when gazing point is in the range of it.
 - Only when the moving of the gazing point is less than 50 pixels (Prevention of vision shaking)



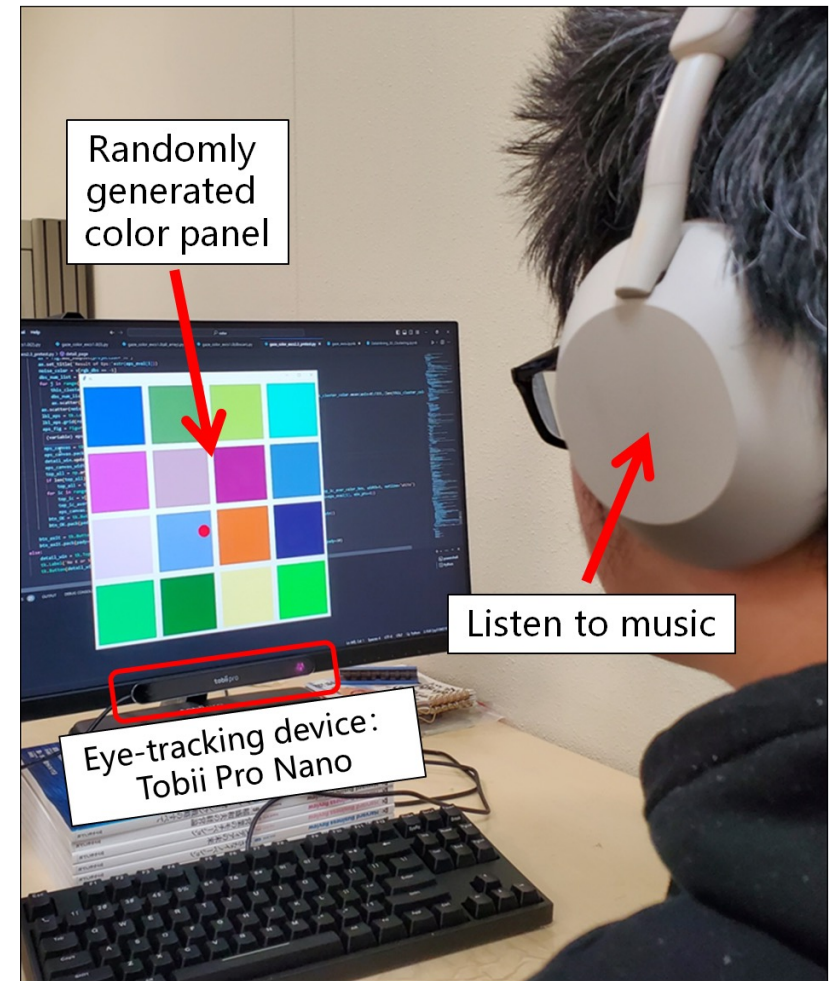
Clustering & Visualization of Color Records

- Estimate users' gazed color categories from color records via clustering analysis
 - DBSCAN method to detect noises
 - Number of clusters → Number of gazed color categories
Records in each cluster → Gazed frequency of the color
 - Average RGB value of each cluster
→ Representative color of the color category
 - Show Top-3 average colors of the gazed frequency;
Visualize the 3D-space distribution of color records' RGB values



Experiment of Estimating Imagined Colors from Music

- Experiment Steps:
 1. Prepare music from different genres
 2. Have the participant listen to a prepared music
 3. Show the color panel five seconds after the music played and begin to track the participant's sight
 4. Ask the participants to seek and gaze at the imagined color that they feel from the music
 5. Record the participant's gazed colors with the proposed system
 6. Repeat the steps from 2 to 5 until all the prepared music was played



Experiment Data & Settings

- Prepared Music

- Six genres of music: Rock, Ballad, and Pop, each with male-vocal and female-vocal.
- Three songs in each genre, 18 songs in total.
- Only English songs to avoid the linguistic affect from lyrics.

	Rock	Ballad	Pops
Male Vocal	KiLLiNG ME, Remember, Jagerbomb	8 Letters, One Call Away, Too Good At Goodbyes	Lucky Strike, Runaway Baby, Say Somethin'
Female Vocal	Feel A Thing Lonely Girl Despondency	Lose You To Love Me, Thinking About You, Rise Up	Black Magic, No Excuses, Into You

- Duration: 30 seconds per song
 - 5 seconds introduction + 25 seconds recording
- Participant: 10 Japanese university students

Experiment Results (I)

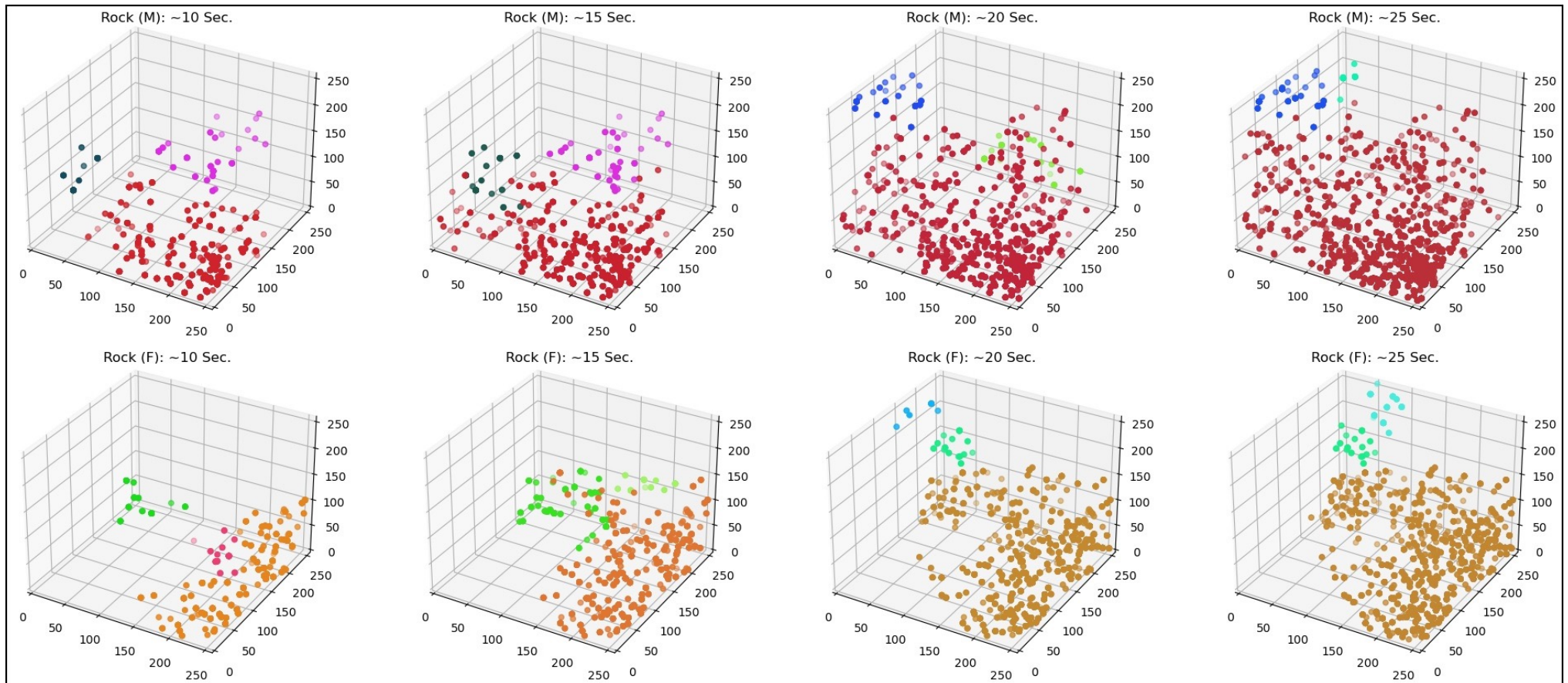
- Percentage change of Top-3 clusters' records under different recording durations (Seconds)

Genres	10 sec.			15 sec.			20 sec.			25 sec.		
	Top1	Top2	Top3	Top1	Top2	Top3	Top1	Top2	Top3	Top1	Top2	Top3
Rock (M)	0.736	0.050	0.025	0.774	0.046	0.026	0.860	0.019	0.018	0.929	0.021	0.007
Rock (F)	0.608	0.054	0.049	0.718	0.114	0.028	0.858	0.019	0.010	0.876	0.017	0.015
Ballad (M)	0.241	0.155	0.120	0.778	0.033	0.031	0.829	0.034	0.026	0.941	0.009	0.005
Ballad (F)	0.139	0.099	0.083	0.833	0.033	0.026	0.904	0.043	0.019	0.986	0.004	0.003
Pops (M)	0.585	0.085	0.034	0.751	0.107	0.021	0.800	0.111	0.011	0.934	0.014	0.010
Pops (F)	0.523	0.061	0.058	0.614	0.196	0.045	0.908	0.007	0.007	0.926	0.008	0.006

- All genres' Top1 cluster gained a proportion close to or over 0.9 at the recording time of 25 seconds.
- Rock & Pops' Top1 clusters were over the proportion of 0.5 from the initial 10 seconds.
 - Imagined colors of Rock & Pops to people were more focused
- Ballad's Top1 clusters showed a significant proportion increment at recording time from 10 to 15 seconds.
 - Several minor color clusters (color categories) may have been merged

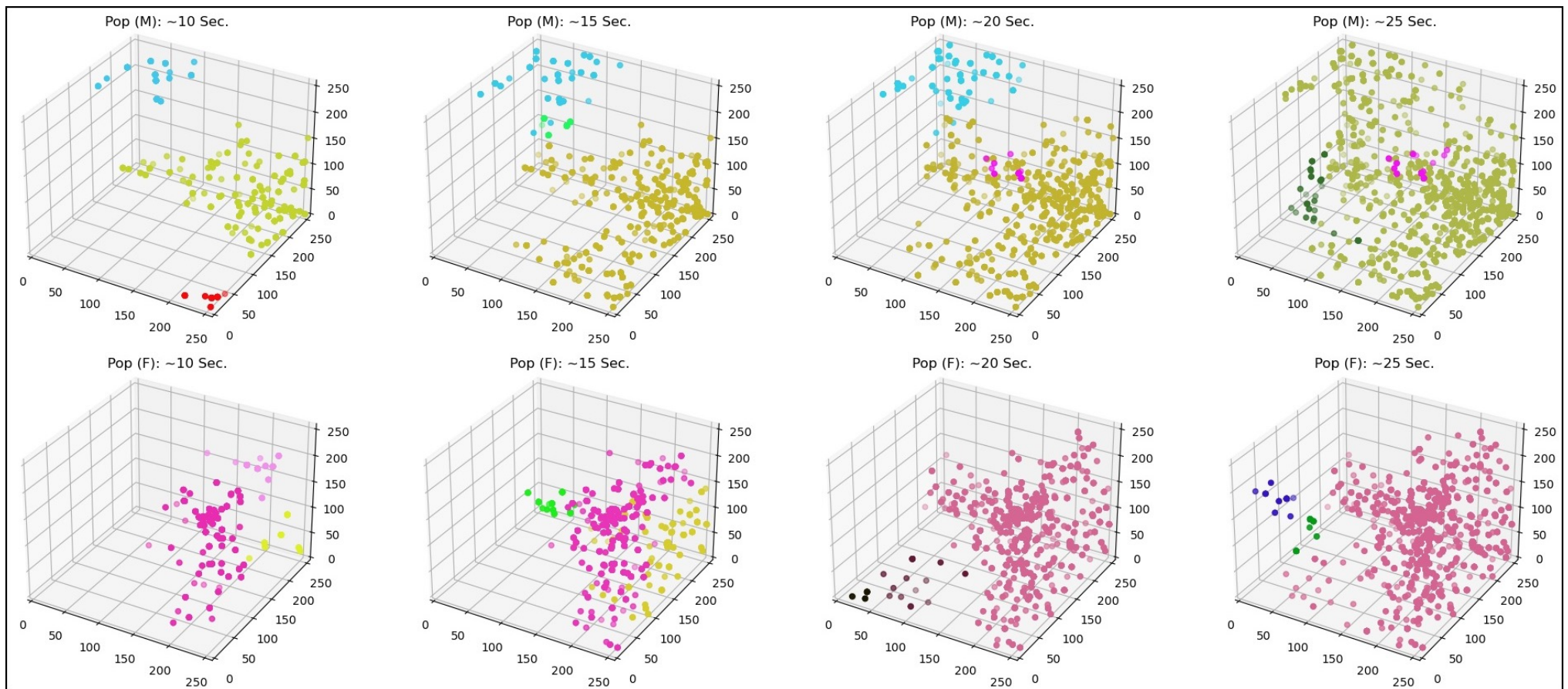
Visualization Results (Rock)

- Growths of the Top-3 most gazed color clusters of all ten participants for the Rock genre in 3D RGB space.



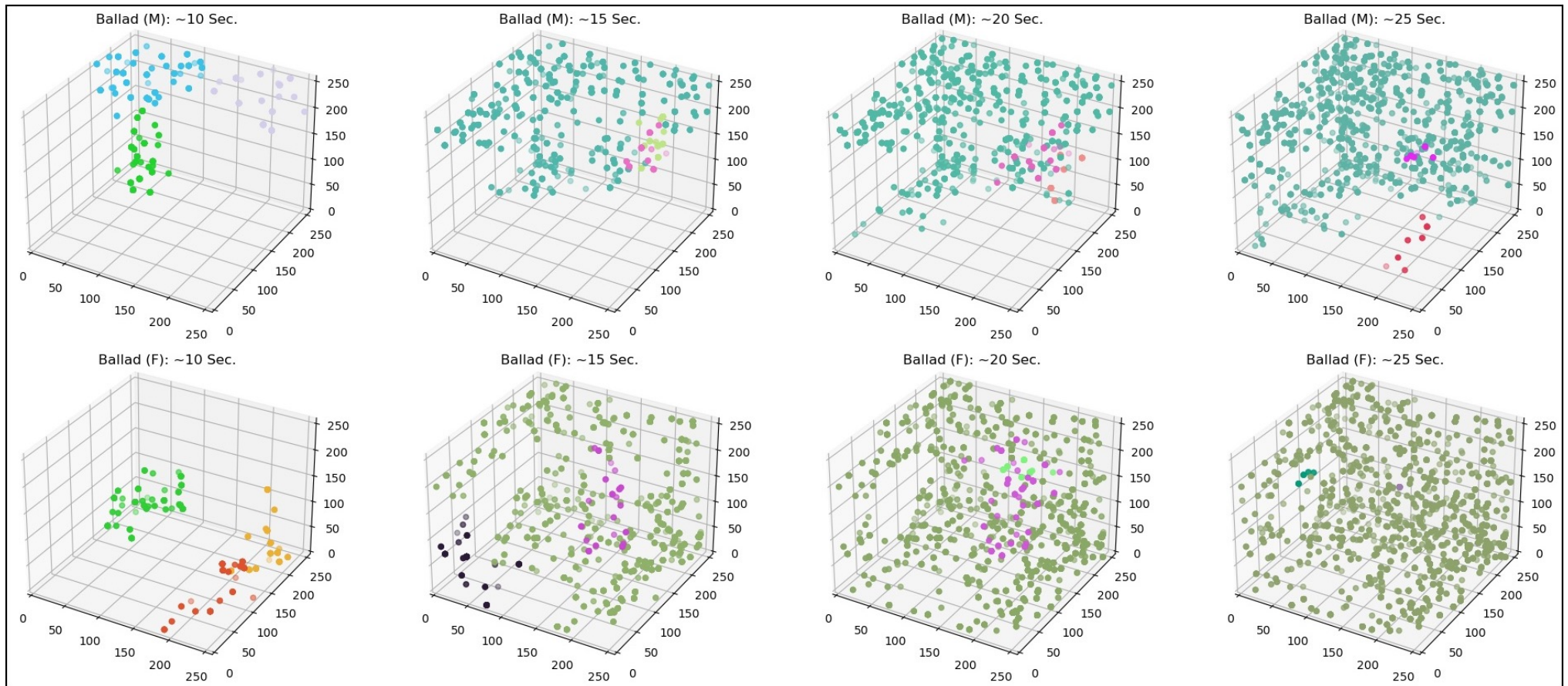
Visualization Results (Pops)

- Growths of the Top-3 most gazed color clusters of all ten participants for the Pops genre in 3D RGB space.



Visualization Results (Ballad)

- Growths of the Top-3 most gazed color clusters of all ten participants for the Ballad genre in 3D RGB space.



Conclusion & Future Work

- A method using eye-tracking device to intuitively estimate the imagined color from the feelings of music without specialized theories or processings.
 - Eye-tracking to record from random colors
 - Clustering records to obtain imagined color categories
- Measured people's imagined colors of six genres of music through participant experiments
 - Five genres of music obtained relatively focused representative colors, except female-vocal Ballads.
- Plans to extend participants' profiles to further explore the ages and cultures' influences on the imagined colors of music.

A red L-shaped graphic consisting of a vertical line on the left and a horizontal line extending to the right, intersecting at the top-left corner of the text area.

Thank you very much!