Sharing the Soundtrack at Home: The Role of Collaborative Music Control on Social Interaction

Abstract. Consuming music in a shared environment is a pleasurable activity that facilitates social interaction and a sense of community among co-located users. However, the control of music is often limited to one user which can cause a feeling of exclusion and impact social interaction negatively. In this paper, we explore how shared control over music playlist functions among co-located users influences social interaction. We designed two music control boxes that provide non-playlist owners with access to either only the song-skip option or a combination of song, album, and artist-skip options. Through a mixed-subject experiment (N=27), we evaluated their evoked social interaction in terms of social connectedness and team performance against a baseline of no music control access. Results of our study indicate that providing access to shared music playlist functions empowers users and facilitates communication among them. It particularly encourages discussions and interactions around diverse music tastes and creates also a space for sharing thoughts and feelings with one another. Based on the insights, we discuss aspects to design future collaborative music systems toward higher social interaction.

Keywords: Collaborative music control · Social connectedness · Team performance · Home.

1 Introduction

The way we consume media has changed considerably in the past 20 years [7]. Through the development of online streaming platforms, any type of media can be accessed from various devices, at any time, from any place. Additionally, sharing and consuming media with someone else became more convenient and easier to handle [43, 46]. Especially music evolved as a consumer good that inherent social experience [7] and connects people, particularly in shared spaces [8]. Recent statistics outline, that an average person spends a total amount of 18.4 hours a week listening to music [15], mainly at home (63%) to relax, enhance well-being but also to socialize with other household members [16].

However, the control of music in a social setting, particularly at home among co-located users is often limited to one user at a certain time. Examples can be a smartphone connected to a Bluetooth speaker or when streaming music from the TV or an (online) source/app using personal devices such as a smartphone. Research reports that limiting people in the participation of control can cause conflicts, frustration, and a feeling of exclusion [17]. One way to overcome these issues is the design of interactive, collaborative systems that support a group in making control decisions together [21, 30] by enabling contributions by several users at once [26]. While this encourages active involvement, and can support the overall group-decision making as well as team performance [31], it also has the potential to enrich social interaction and individuals' perceived social connectedness [4]. Designing for collaborative music control, O'Hara et al. report that providing a democratic way of selecting songs in public spaces enhances social interaction and communication among strangers [29]. Such a democratic way of music selection also supports fairness and enhances individuals' belongingness towards the group, however, it is time-consuming and introduces a dependency on others [4]. Providing different hierarchical access levels to certain music/playlist functionalities is the most prominent way of enabling collaboration [35], however, it is perceived as less fair [35] even though it facilitates a structured collaboration and ensures verbal communication [4]. In contrast, allowing only one user to control entertainment in a shared space let others feel excluded, and treated unfairly, which can impact group-decision making and also individuals' perceived social connectedness negatively [4, 29]. Taken together, limiting individual control contribution can affect social interaction and the whole experience negatively while promoting collaborative control has the potential to support group-decision making and team performance while enriching social connectedness.

While some research has focused on enabling collaborative music control for distributed users (e.g., [13, 6] and facilitating collaborative music control towards social interaction in public spaces (e.g., [29]) or safety-critical environments (e.g., in the car [4]), little is known about how to design for collaborative music control in the home to support social connectedness and team performance. To overcome this limitation, we see the need to explore how to design for the collaborative control of music among co-located users in the home and to study their influence on team performance and perceived social connectedness. In this paper, we focus on answering the following research question (RQ): *How to design for shared control over music in the home to support social connectedness and team performance among co-located users?*

To this end, we designed shared music control boxes for two different types of collaborative music control (for the design see Section 3) - the first provides access to the song-skip function while the second one provides access to song, album, and artist skip functions. We evaluated their effect on social connectedness and team performance through a mixed-design lab experiment in groups of three (N=27). With the insights gained, we contribute to users' perception of team performance and social connectedness in the home when collaboratively controlling music. Secondly, based on these insights we discuss important elements for future collaborative music systems in the home context to conquer social connectedness and team performance.

2 Background & Related Work

Listening to music is a pleasurable activity that connects people for decades [8]. People started sharing physical objects such as CDs or mixtapes until the early 2000s when music collections migrated to digital formats. Nowadays, streaming platforms enable creating, sharing, and listening to music together [43, 8]. Particularly among co-located users, the collaborative consumption of music can have a major impact on social interaction [33, 32]. Sharing music tastes and experiences can foster social bonds with others [32], enable discovering new songs [33], and enriches interaction with other people [33, 32]. Besides, listening to music in a shared space can be fun, engaging, and a way to share interests with one another [47]. Thus, designing interactive systems with a focus on collaborative usage can enrich (social) experiences. In the following, we provide an overview of co-located collaboration and discuss prior findings concerning collaborative media/music systems and how to best design for collaborative, interactive music systems.

2.1 Understanding the social aspects of collaboration

We, humans, aim for social interaction in order to exchange thoughts, actions, and reactions among others. Thus, social interaction naturally occurs in situations where people collaborate. When it comes to the execution of certain tasks in a collaborative setting, the success of a team gets influenced by the individual's perceived team performance (team cohesion, coordination effectiveness) [31] and social connectedness - belongingness, affiliation, and companionship, towards the group. Affiliation, in particular, is a key factor in social interaction and helps to maintain a social bond between group members [45]. This is supported by research which has shown that individuals who feel a sense of affiliation within the group are more likely to engage in prosocial behavior and contribute to the group goal [27]. A high level of companionship also impacts satisfaction positively because it supports well-being and reduces stress [37]. Furthermore, research outlines that communication [14] is essential for effective teamwork [34] which has a direct impact on collaboration and can maintain team performance as well social connectedness. Besides that, collaboration is defined by factors such as people's personalities [40], and the size of the group [38]. This means that users become less satisfied and less productive the more people are in a group, notably with six or more members [2, 39]. In summary, a successful and satisfactory group collaboration, according to social psychology, gets not only influenced by individuals' level of contribution possibilities but also by the perceived team performance and social connectedness. Factors such as affiliation, companionship, effective communication, group size and personality can play a role in determining the success of a group.

2.2 Collaboration among co-located users on media/music content

The design of collaborative systems for co-located users involves creating technology that enables multiple people to work together to select and view media content while they are in the same physical location. This might involve the use of shared devices, and multiple devices, as well as the development of dedicated user interfaces, to manage/select content together. Research and industry thus investigated diverse applications to support collaboration on media content (e.g., [43, 13, 29]). O'Hara et al. developed *Jukola*, a democratic music choice platform for public spaces [29]. Users can vote for songs that should be played using smartphones placed on a table for instance inside a bar or a restaurant [29]. Brown et al. developed the *Music Buddy*, a system that allows browsing others' music collections on personal devices which helps socializing with friends [6]. With *Push!Music*, Hakansson et al. implemented a mobile sharing system that recommends songs depending on nearby players and thus acted as a starter for social interaction [13]. A recent study on in-car music selection by Berger et al. [4] shows that voting for songs fosters social connectedness and encourages communication. Restricting control instead induces power games and is perceived as unfair which negatively impacts social interaction [4]. Providing different access levels to functions is among the most common approaches to enable collaboration [35, 26]. While this sounds promising in involving all users actively, research shows that this can provoke unbalanced power dynamics and is perceived as less fair [35] even though it facilitates a structured collaboration and ensures verbal communication [4]. Additionally, receiving information about what friends or family members are interested in can enhance the feeling of belongingness [**?**] and contributes positively toward workspace awareness - seeing what others contribute towards the group goal [11]. Nevertheless, recent work reports that the usage of personal devices (e.g., smartphones) to tends to pull the group apart despite being physically close [20]. In general, research shows that to best support collaboration, an interactive system needs to be centered around the group of users [36] and enable any group member to participate actively [18, 23]. To be able to design for individual contribution and social connectedness, a clear balance of the presence of who decides on what [26, 23], a reasonable group size [2, 39], and individual access to functions are key [10].

While literature shows that collaborative control of media systems has the potential to stimulate social interaction and outline how the usage of multiple, personal control devices encourages collaboration and influences social interaction (e.g., [4, 29]), little is known, about how we can design shared control devices to enhance the social experience among co-located users when listening to music together. With our study, we intend to fill this gap and investigate how distributed control across group members by means of shared devices enhances social connectedness and best support music decision-making for groups of people that are physically close.

3 Designing for collaborative music control in the home

With the design of collaborative music control, we aim to support co-located users to interact with one another and to stimulate social interaction. Our spotlight lies in the exploration of how we can design for shared control of music among co-located users in the home to positively affect social connectedness and team performance. Since music gets frequently consumed in the home [16], and the average household size in Europe compromises 2.2 people [9], we focused on the exemplary use case of three users in a shared room at home listening and controlling music together.

3.1 Design of collaborative approaches to music control in the home

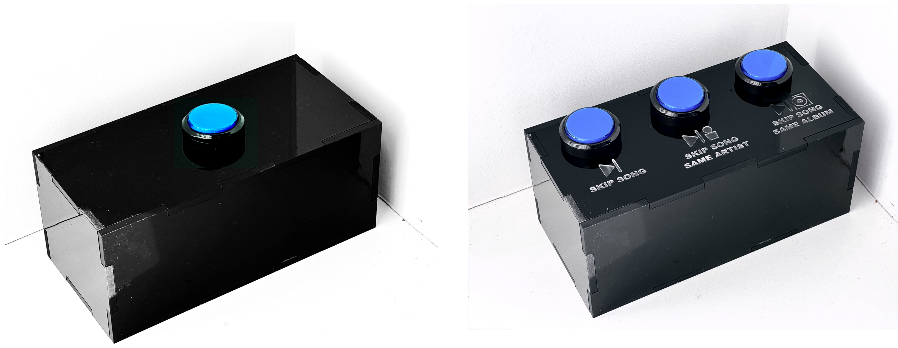
For the design of collaborative approaches to music control, we initially concentrated on providing a physical shared device for controlling music, due to the fact that personal devices (e.g., smartphones) tend to detach users from one another despite being physically close [20]. Sharing a physical device instead can foster social interaction and togetherness [42]. Therefore, we developed a so-called music-control box with dedicated physical buttons that can be pressed to change music in order to explore collaborative approaches to music control. We initially focused on sharing control over skip functions only since skipping songs is among the most common behavior of users when listening to music [25].

Thus, our concepts base on different levels of control possibilities per user [35, 26], which means that not every user has the possibility to perform every available function (limited access) [10, 28]. In our music use case, we have the key user, represented by the playlist owner who has access to all possible playlist functions (e.g., via a dedicated digital user interface accessed with a smartphone or laptop). Additionally, we have the none-playlist owner(s) - for those we want to provide control to the skip functions. We therefore designed two main collaborative approaches to music control, described below, which vary in their possibility of providing non-playlist owners access to skip functionalities. We specifically chose a physical control device to encourage active engagement, as studies have shown that a graphical user interface - depending on the amount of information - can be distracting and negatively impact social interactions [4].

Hierarchical single-skip music control: This concept provides none-playlist owners with the possibility to only skip the current song and thus enables them to participate in controlling music while not counteracting main decisions made by the playlist owner (e.g., changing playlist, skipping all songs from an artist). The box thus is equipped with a single, physical button as shown in Figure 1a.

Hierarchical multi-skip music control: This concept provides access to multiple, different skip functions. First, none-playlist owners have the possibility to skip the current song. Additionally, there are the options to skip the artist or the album of the currently played song. The control box therefore provides users with three different buttons, labeled with the underlying function as outlined in Figure 1b.

Autocratic music control: For completeness, we added the *Autocratic music control* concepts which reflects the current status quo of having only a key user who can control the music. In our situation, this refers to the owner of the music playlist. Other users in the room cannot directly access music functions (no music-control box available). They are limited to convincing the key user by other means e.g., communication in order to request changes.



(a) Designed control box with a single button to enable none playlist owners to skip the current song.

(b) Designed control box with three buttons to enable none playlist owners to skip the current song, or skip the full album or artist of the current song.

Fig. 1: Demonstration of the music control boxes - left for Hierarchical single-skip control and right for Hierarchical multi-skip control.

4 Research Question & Hypotheses

The experience of co-located users controlling a system or service together gets influenced by individuals' perceived social connectedness [4, 2, 19, 37] and team performance [31]. We see these factors as an indicator of collaborative music control. To explore how the collaborative music concepts support collaboration and social interaction we ask: *How does shared control of music in the home influence social connectedness and team performance among co-located users?*

One of our goals lies therefore in the qualitative exploration how users control music together and how they perceive collaboration and group decision-making. Besides, we want to initially explore whether there is a difference in the perceived social connectedness (H1) and team performance (H2) depending on the type of collaborative concept.

H1 *The type of collaborative music control has an effect on the perceived social connectedness in terms of belongingness, affiliation, connectedness and companionship*

H2 *The type of collaborative music control has an effect on the perceived team performance in terms of coordination effectiveness and team cohesion*

5 Comparative study of the collaborative music concepts

To investigate the concept's impact on collaborative experience, we conducted a mixed-subject experiment in a lab.

Independent variables: The three concepts (*Hierarchical single-skip control, Hierarchical multi-skip control, Autocratic control*) were our within-subject variable and the type of control (key-user/playlist owner, none-key-user / none-playlist owner) the between-subject variable. The key-user is the user having access to the full music playlist while the none-key-users can only control the music by using the provided control box.

Dependent variables/measurements: We assessed the individual perceived social connectedness in terms of connectedness, companionship, and group affiliation using the Social Connectedness Scale [19] and group belongingness by means of the Community in Self Scale [22]. For the team performance, we measured users perceived team cohesion and coordination effectiveness using Paul et al.'s Team Performance Questionnaire [31]. As an influencing factor, we investigated the evoked User Experience (UX) in terms of hedonic, pragmatic and overall UX, using the short user experience questionnaire (UEQ-short) [41]. To investigate the concepts' positive and negative evoked qualitative impressions, we conducted semi-structured group interviews after each concepts' test ground and at the end of the experiment.

5.1 Participants

By means of convenience sampling, we recruited 9 groups of three students within the author(s) institution (makes a total of N=27, 4 same-gender groups, 5 mixed-gender groups). We explicitly recruited people who either worked on projects together or considered themselves as a group of friends to balance possible influencing factors that can come from collaborating with strangers [20]. Overall, 18 male, 8 female participants, and one preferred not to answer, living in a country in Europe (blinded for review), aged from 18 to 26 years ($M = 23.4\text{years}, SD = 1.8$ years) participated in the study. When it comes to listening to music together with others, 2 out of 27 reported doing so all the time, 14 at least two times a week, 10 less than once a week, and one reported never listen to music with others.

5.2 Technical Set-Up

For the music playlist itself, we used the common Spotify desktop version, hosted on a laptop. For the test, we created a pre-defined playlist that consisted of 243 songs, put together from pre-defined Spotify hit lists (e.g., Top 50 - Global, Viral 50 - Global). Thus, the playlist was filled with the most prominent, global songs from October 2022 including songs from e.g., Harry Styles, OneRepublic, Sam Smith to ensure that participants are familiar with the songs [44]. To receive the input from the music-control boxes, we used an esp32, connected to Wifi. The incoming button presses got handled by a web service which further called the

Fig. 2: Study set-up in the lab. Three participants are sitting at a round table. The key-user has access to the music playlist by means of a laptop, while the other two users can use the controller to express their needs.

dedicated Spotify API method corresponding to the underlying button function (skip song, skip album, skip artist). The experiment got performed in an empty lab containing a round table and three chairs (see Figure 2). The chairs were positioned in a way, that the non key-users were not able to see the playlist to mimic real-life scenarios of not being able to access the playlist directly.

5.3 Procedure

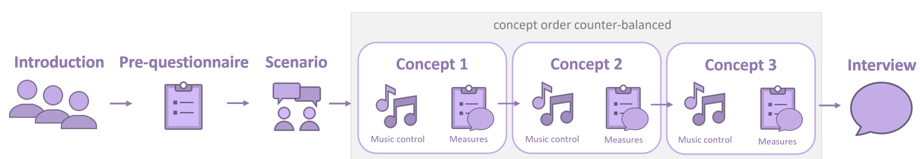


Fig. 3: Visual representation of the study procedure. The sequence of the concepts was counterbalanced. (icons by Icons8)

First, we introduced the goal of the study and collected informed consent. We then handed out a questionnaire related to demographics and music-listening experience. Afterward, we defined randomly the key-user (the participant interacting with the laptop and in charge of the playlist) and let them take a seat around the table (the sitting position and roles did not change throughout the experiment). The goal was to investigate the concepts' effect on social experience rather than the level of self-explanation of the control boxes. Thus, we instructed the music-control boxes before each test round. Additionally, we introduced the key-user to being allowed to change the music at any time, using all available Spotify playlist functions during the test stages (play/pause, prev/next, adjust volume, select a specific song from the list). Besides we encouraged the group to talk with one another and explicitly mentioned that requesting changes to be performed by the key-user is always allowed. To simulate a social situation, we presented the participants with a social scenario of being roommates and having a cozy evening in the living room while listening to music together. Therefore, they got 15 minutes per concept to control/listen to music together.

The experiment started with an introduction to the social scenario. This was followed by a fully counterbalanced set of the three collaborative music concepts. For each concept, the group had to use it for 15 minutes. In the end, the participants filled out questionnaires related to social connectedness, team performance, and UX. In addition, the researchers asked about participants' positive and negative impressions of each concept. The experiment concluded with a semi-structured group interview about what they liked/disliked about the evoked social experience. The experiment lasted on average 1.5h while participants did not receive compensation. The experiment was approved by the Ethics Committee of the researcher(s) institution.

6 Results

We report how each concept affects users' perceived social connectedness, team performance, and UX. Due to the Likert scaled data from the team performance [31], social connectedness [19, 22], and UX [41] questionnaires, we conducted Friedman tests to investigate differences between the concepts. For the post-hoc pairwise comparisons we performed Bonferroni-corrected Wilcoxon signed rank tests.

6.1 Social Connectedness - H1

Belongingness: A Friedman test does not show significant differences in the perceived belongingness between the three collaborative concepts ($\chi^2(2) = 3.5, p = .174$, Figure 4a). Overall, all concepts evoke at least an average feeling of belongingness. The *Autocratic control* ($Mdn = e$) and *Hierarchical multi-skip control* ($Mdn = e$) scored slightly higher than *Hierarchical single-skip control* ($Mdn = d$).

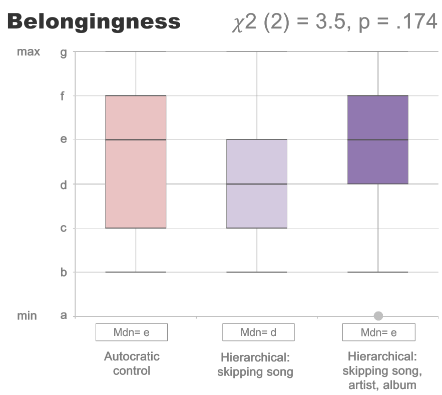
Companionship: The evoked companionship among the concepts is not significantly different, as outlined by a Friedman test ($\chi^2(2) = 4.7, p = .095$). The median scored companionship is equally high for all three concepts ($Mdn = 5$), see Figure 4b.

Connectedness: There is no significant effect of the concepts on perceived connectedness ($\chi^2(2) = 3.84, p = .147$, Figure 4d). All concepts scored above average with the highest score evoked by *Hierarchical single-skip control* ($Mdn = 5.5$), followed by *Hierarchical multi-skip control* ($Mdn = 5.25$), and *Autocratic control* ($Mdn = 5$).

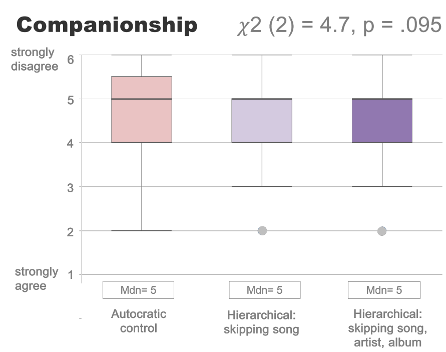
Affiliation: There is a significantly difference in the evoked affiliation based on the collaborative concepts, as shown by a Friedman test ($\chi^2(2) = 10.19, p =$

.006, Figure 4c). Post-hoc pairwise comparison outlines a significantly higher affiliation for *Autocratic control* compared to *Hierarchical multi-skip control* ($Z = 2.518, p = .035$). Thus, our results indicate *Autocratic control* to support affiliation best, especially compared to *Hierarchical multi-skip control*.

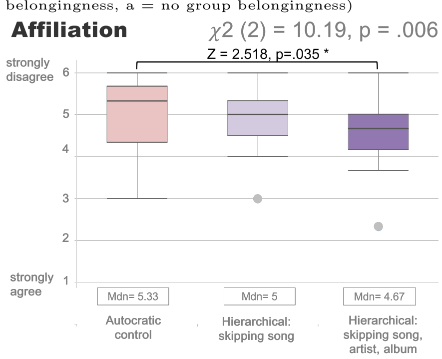
Taken together, the three concepts stimulate similarly high belongingness, companionship, and connectedness while evoking differences in perceived affiliation. This leads us to only partially accept *H1 - The type of collaborative music control has an effect on the perceived social connectedness in terms of affiliation*.



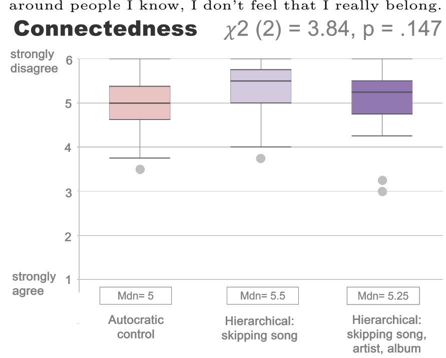
(a) Distribution of the measured group belongingness of each concept [22] (g=max belongingness, a = no group belongingness)



(b) Distribution of the measured companionship of each concept [19]. Q: Even around people I know, I don't feel that I really belong.



(c) Distribution of the average measured affiliation of each concept [19]. Q1: I don't feel I participate with anyone or any group; Q2: I have no sense of togetherness with my peers.; Q3: Even among my peers, there is no sense of brother/sisterhood.



(d) Distribution of the average measured connectedness of each concept [19]. Q1: I feel so distant from the other people; Q2: I feel disconnected from the world around me; Q3: I don't feel related to anyone; Q4: I catch myself losing all sense of connectedness.

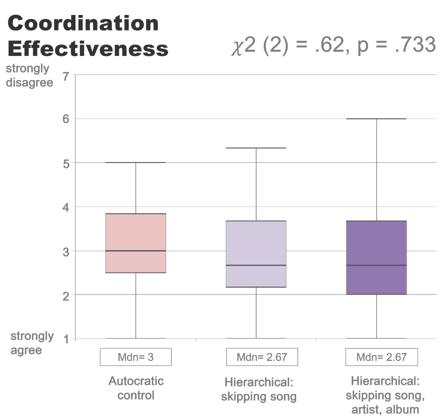
Fig. 4: Social connectedness measurements across the different concepts with pairwise comparisons. Friedman tests are significant at $p < .05$. Bonferroni-corrected Wilcoxon signed-rank post-hoc tests are marked with * when significant.

6.2 Team Performance - H2

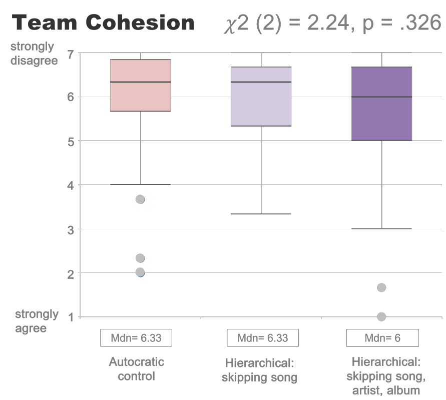
Coordination Effectiveness: A Friedman test does not show significant differences in the evoked coordination effectiveness among the three concepts ($\chi^2(2) = .62, p = .733$). Overall, the coordination effectiveness is rated higher than average for all concepts (Figure 5a), with the best score for both *Hierarchical control* concepts ($Mdn = 2.67$), followed by the *Autocratic control* concept ($Mdn = 3$).

Team Cohesion: There is no significant differences in perceived team cohesion among the concepts as outlined by a Friedman test ($\chi^2(2) = 2.24, p = .326$, Figure 5b). The team cohesion is high for all three concepts. *Autocratic & Hierarchical single-skip control* ($Mdn = 6.33$) scored best, slightly followed by *Hierarchical multi-skip control* ($Mdn = 6$).

Summed up, the concepts evoke a similarly high team performance with no difference in perceived coordination effectiveness or team cohesion. Therefore, we reject H2 and conclude that the type of collaborative music control has no effect on the perceived team performance.



(a) Distribution of the average evoked coordination effectiveness per IVIS concept [31]. (Q1: I am satisfied with my communication with the team members. Q2: There was a clear sense of direction during discussions with the team members. Q3: The interactions between the group members were well organized.)



(b) Distribution of the average evoked team cohesion per IVIS concept [31]. (Q1: Dealing with the members of the team often left me feeling irritated and frustrated. Q2: I had unpleasant experiences with the team. Q3: Negative feelings between me and the team tended to pull us apart.)

Fig. 5: Team performance measurements across the different collaborative IVIS concepts. Friedman tests are significant at $p < .05$.

6.3 User Experience

The overall UX is highest for the *Hierarchical multi-skip control*, followed by *Hierarchical single-skip control*, and *Autocratic control* (Figure 6). A Friedman test shows a statistical significant difference in overall UX ($\chi^2(2) = 18.41, p < .001$). Post-hoc comparisons outline a significant higher overall UX for *Hierarchical* *multi-skip control* ($Z = -4.08, p < .001$) and *Hierarchical single-skip control* ($Z = 2.86, p = .013$) compared to *Autocratic control*. Looking into UX more detailed, there is a significant differences in terms of pragmatic quality (practical, simple, pleasant) ($\chi^2(2) = 9.584, p = .008$). Pairwise comparisons show a significant higher pragmatic quality for *Hierarchical single-skip control* compared to *Autocratic control* ($Z = -2.994, p = .008$). Concerning hedonic quality (satisfactory, creative, original) ($\chi^2(2) = 26.9, p < .001$), the *Hierarchical multi-skip control* ($Z = -5.0354, p < .001$) as well as the *Hierarchical single-skip control* ($Z = -2.772, p = .019$) scored significantly higher compared to *Autocratic control*.

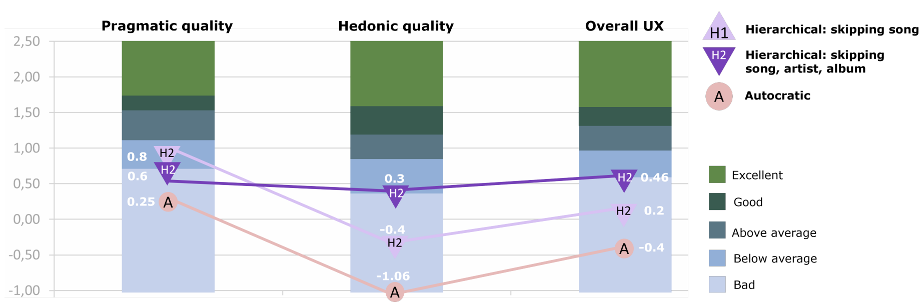


Fig. 6: Results from UEQ-short [41]. It shows the mean values of the measured pragmatic quality (left), hedonic quality (middle), as well as the overall UX (right) score per concept. The colors of the bars represent the UX scale, ranging from excellent (light green) to bad (light blue). The scale in general ranges from -3 (horribly bad UX) to +3 (extremely good UX), while values above 0.8 represent a positive evaluation [41].

6.4 Qualitative Feedback

We conducted a qualitative content analysis with the responses to the open-ended questions concerning each concept individually and the final interview. Sentences were iteratively assigned to themes which are outlined in Figure 7 and in more detail reported below.

The Hierarchical multi-skip music control is described by participants as *fun*, *useful*, *supportive* and evoking *curiosity* (e.g. "*The three buttons are very useful to control music*", P#2.2; "*We are curious about the next song in the album*", P#3.3). Especially the three buttons are perceived as an *effective* way to switch to other types of music (e.g., "*I will also use these three buttons because it saves a lot of time for me to check the artist or the album if I want to listen to a similar song*", P#2.1; "*More quick control of music*", P#5.2). Additionally, participants mentioned that due to the provided control to other users, it enables active participation in decision-making and supports collaboration (e.g., "*It gave me a chance to select my music*", P#2.2, "*We were kind of working together*", P#5.3). Some participants experienced this as a form of better connecting with the other users (e.g., "*I felt more connected to the other two people*", #P2.2). Additionally, this concept *encourages conversations about the music* itself (e.g., "*It can provide us more topics to communicate about*", P#3.2, "*We discussed the artists and albums more*", P#1.2). However, some were also overwhelmed with the diverse buttons and found them too *complex* to be used (e.g., "*It is a little bit too complex - the second and third button*", P#4.3). Besides, one user fears that it can also lead to *disagreements* and to the fact that you never *listen to the full song* (e.g., "*I think we just skipped multiple songs [...] I don't think we even finished one song*", P#7.1).

Fig. 7: Visual representation of the themes derived from the qualitative content analysis. The colors represent the different concepts. The numbers represent how often a theme got mentioned.

The Hierarchical single-skip music control is described as *interesting*, but *not novel* (e.g., "*I think it is quite interesting*", P#1.2; "*It is not cutting edge*",P#1.3). Through the single button interaction, users can *easily participate* in controlling the music (e.g., "*I just need to press this skip button*", P#3.3). Participants feel that it promotes *self-determination* (e.g., "*I can press it when I want*", P#2.2) and creates a novel *experience*, particularly due to the *curiosity* which song will come next (e.g., "*It is more [...] random and I don't know the next song*", P#8.2; "*I like the uncertainty of the next song*", P#2.2). This also enables any user to change the vibe in the room (e.g., "*What I really want to do is to change the vibe and I just need to press this button*", P#3.3). Nevertheless, they see the need of finding *agreement* before skipping a song (e.g., "*I still need to ask their agreement*", P#2.3). This particularly *encourages communication* and allows to *explore others preferences* concerning music (e.g., "*I have to communicate with you like if you want to play this song*", P#3.2). This opens up a space where they more likely share openly their thoughts and ideas (e.g., "*I could express my interests easily*", P#5.2). Even though the *control* itself is to some extent perceived as *limiting* and as having*dependency on a key-user* when other functions want to be performed (e.g., "*They had fewer choices, so I had to help*", P#8.1), it is perceived a *fun* and *useful* way of listening and controlling music together.

The Autocratic music control is described as *traditional* but also *time-consuming*, particularly for the user in charge over the playlist when looking for dedicated songs others request (e.g., "*Is kind of the most normal way*", P#4.2, "*He said, we wants [...] rock. So I have spent a while to search for it*", P#7.1). Since one user is *responsible for others interests* (e.g., "*It is responsibility to listen to the other peoples' opinion*", P#8.1), a few participants fear that this can *lead to conflicts*, particularly when *agreements* cannot be made (e.g., "*Can elicit many conflicts*", P#1.1). Due to the key-user, the autocratic music control is perceived as *encouraging communication* (e.g., "*We discuss everything*", P#5.3). Interesting to note, it does not only provoke music-related conversations, but also talk about any other topic. Therefore, participants mentioned that they *Forgot to change the song* because it was also not obvious that it was possible (e.g., "*You talk more about different things than music, simply because you forgot you can influence*", P#3.2). Others even had the feeling that it is currently not necessary to request any changes in music which lead to the fact that the group listens more likely to the *full song* (e.g., "*We just listen to a real song until the end*", P#9.2).

7 Discussion

We present in this paper two concepts for shared music control among three users in the home context which provide non-playlist owners access to song skip functions. Through an empirical examination of the two concepts (*Hierarchical single-skip concept*, *Hierarchical multi-skip concept*) against the baseline of only the playlist owner controlling music (*Autocratic concept*), we studied the concepts' evoked social interaction by measuring individuals' perceived social connectedness and team performance. Results show a high evoked social connectedness and team performance for all concepts. Through qualitative insights, we found that providing users with access to playlist functions promotes easy participation, encourages communication, and the exchange of their interests while also generating curiosity related to the music itself. In this section, we discuss the implications of our findings toward promoting social interaction by designing for shared music control.

7.1 Implications of shared music control on social connectedness & team performance

Our research indicates that providing multiple users in the room physical access to music control establishes high social connectedness as well as team performance which ultimately supports, well-being [37], and a sense of belonging towards the group [19]. This aligns with previous studies that have highlighted the importance of social connectedness and shared control experiences in group decision-making processes [4, 35]. Furthermore, we found that distributing control over music functions differently has an impact on perceived affiliation within the group. Particularly, the traditional *Autocratic control* approach evokes a higher sense of affiliation, but also induces feelings of dependency and exclusion among users. This can to some extent be attributed to the familiarity of the concept [**?**], but also to the necessity of communication [4, **?**] to initiate changes.

On the other hand, providing group members with access to music control enables easy participation and stimulates discussion and exchange of ideas, moods, and music preferences. This in turn also allows exploring others' interests [4] and opens up a space where people feel free to express themselves and act self-determined. This initiates social interaction because it particularly supports getting to know each other better and understanding the individuals' mood for music. Moreover, the button lowers the threshold to request changes, which can be particularly relevant for users who may be hesitant in group settings [40]. Additionally, pressing buttons, especially in the context of music control, can be enjoyable and create a sense of anticipation toward music changes. However, too many buttons and options can make the device confusing and reduce its perceived usefulness.

In summary, our research emphasizes the significance of considering user involvement and empowerment in the development of future physical music control systems in the home. It is crucial to ensure users feel included and valued in the decision-making process to improve social interaction and create a unique experience in shared spaces. Beyond initiating conversations, it is important to provide users with easy access to control and the ability to act self-determined because it fosters communication and the exchange of ideas and moods. Additionally, designing the system with user experience in mind [12] and considering the potential impact of the songs [44] on the group experience can greatly enhance the overall experience. We recognize the limitations of our study, such as the lack of emphasis on product design which was reflected in the low user experience scores, as well as the potential impact of the songs chosen on the group experience. Despite these limitations, our findings provide valuable insights into the potential benefits of collaborative music control in fostering social connectedness and team performance, particularly the support of well-being and a sense of belonging among group members.

Still, our insights reflect only a short testing period with a pre-defined music playlist. Thus, the impact when using the concepts more often, and for a longer period of time, also with user-defined playlists needs to be investigated in more detail. While we ensured internal validity by only recruiting groups of friends, it would be interesting to investigate diverse social group settings i.e., by studying different types of relationships among household members. Since research shows that the personality of individuals can influence social interaction [40], future work is needed to understand how different personality types affect social interaction when controlling music together. While we ensured contextual validity by conducting the study in a controlled lab environment, additional research work should look into possible influences in real-life home settings. Lastly, our data reflects people living in Mid-Europe controlling music together. People with different cultural backgrounds might have varying expectations when it comes to collaboration and music listening at home. Thus, future research is needed to verify whether and how our findings may transfer to other social and cultural contexts.

8 Conclusion

In this paper, we examined the impact of shared control over music among co-located users in the home on perceived social connectedness and team performance. Two music control concepts, the *Hierarchical single-skip music control* and the *Hierarchical multi-skip music control* were designed which provide non-playlist owners access to song skip functions. We evaluated the two concepts in a controlled lab experiment against a baseline of no music control access. Our results indicate that the type of collaborative music control has a significant effect on users' perceived social connectedness - particularly the affiliation towards the group, while team performance remains consistent across all conditions. Further, qualitative data revealed that providing non-playlist owners with access to control functions fosters enjoyable and engaging conversations, mainly around music preferences. Additionally, it facilitates the exploration of diverse musical tastes, ultimately leading to increased social interaction. Our findings contribute to the understanding of how music control can be designed particularly to make control more accessible in shared environments and how it impacts social interaction and group dynamics.

References

1. Ah Kun, L. M., Marsden, G.: Co-present photo sharing on mobile devices. In Proceedings of the 9th international conference on Human com-

puter interaction with mobile devices and services (MobileHCI '07), pp. 277–284. Association for Computing Machinery, New York, NY, USA, (2007) https://doi.org/10.1145/1377999.1378019
2. Ammarapala, V., Luxhøj, J. T.: A Collaborative Multi-criteria Decision Making Technique for Risk Factor Prioritization. Journal of Risk Research **10**, 465–485 (2007) https://doi.org/10.1080/13669870701421563
3. Batterbee, K.: Defining co-experience. In: Proceedings of the 2003 international conference on Designing pleasurable products and interfaces (DPPI '03), pp. 109-–113. Association for Computing Machinery, New York (2003). https://doi.org/10.1145/782896.782923
4. Berger, M., Barati, B., Pfleging, B., Bernhaupt, R.: Design for Social Control of Shared Media: A Comparative Study of Five Concepts. In Nordic Human-Computer Interaction Conference (NordiCHI '22), pp. 1–13. Association for Computing Machinery, New York, NY, USA, Article 14, (2022) https://doi.org/10.1145/3546155.3546694
5. Brook, J.: SUS-A Quick and Dirty Usability Scale. Usability evaluation in industry **189**(194), 189–194 (1996).
6. Brown, B., Sellen, A.J., Geelhoed, E.: Music Sharing as a Computer Supported Collaborative Application. In: Prinz, W., Jarke, M., Rogers, Y., Schmidt, K., Wulf, V. (eds) ECSCW 2001. Springer, Dordrecht. (2001)
7. Cockrill, A., Sullivan, M., Norbury, H. L.: Music consumption: Lifestyle choice or addiction. Journal of Retailing and Consumer Services **18**(2), 160–166 (2011) https://doi.org/10.1016/j.jretconser.2010.12.003
8. Davidson, J. W.: Music as social behavior. Empirical musicology: Aims, methods, prospects, 57–75. (2004)
9. Eurostat, `https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Household_composition_statistics`. Last accessed 21 January 2023
10. Flemisch, F., Heesen, M., Hesse, T. et al. Towards a dynamic balance between humans and automation: authority, ability, responsibility and control in shared and cooperative control situations. Cogn Tech Work 14, 3–18 (2012). https://doi.org/10.1007/s10111-011-0191-6
11. Gutwin, C., Greenberg, S.: A Descriptive Framework of Workspace Awareness for Real-Time Groupware. Computer Supported Cooperative Work (CSCW) **11**, 411-–446 (2002) https://doi.org/10.1023/A:1021271517844
12. Hassenzahl, M.: User experience (UX): towards an experiential perspective on product quality. In Proceedings of the 20th Conference on l'Interaction Homme-Machine (IHM '08), pp. 11–15. Association for Computing Machinery, New York, NY, USA, (2008) https://doi.org/10.1145/1512714.1512717
13. Hakansson, M., Rost, M., Jacobsson, M., Holmquist, L. E.: Facilitating Mobile Music Sharing and Social Interaction with Push!Music, 40th Annual Hawaii International Conference on System Sciences (HICSS'07), pp. 87-87. Waikoloa, HI, USA, (2007) https://doi.org/10.1109/HICSS.2007.225
14. Hinsz, V. B., Tindale, R. S., Vollrath, D. A.: The emerging conceptualization of groups as information processors. Psychological bulletin, **121**(1), (1997)
15. Engaging with Music 2021 `https://www.ifpi.org/wp-content/uploads/2021/10/IFPI-Engaging-with-Music-report.pdf`. Last accessed 21 January 2023
16. Music Listening 2019 `https://www.ifpi.org/wp-content/uploads/2020/07/Music-Listening-2019-1.pdf`. Last accessed 21 January 2023
17. Kittur, A., Suh, B., Pendleton, B. A., and Chi, E. H.: 2007. He says, she says: conflict and coordination in Wikipedia. In Proceedings of the SIGCHI

Conference on Human Factors in Computing Systems (CHI '07), pp. 453—462 Association for Computing Machinery, New York, NY, USA, (2007). https://doi.org/10.1145/1240624.1240698

18. Koch, M., Gross, T.: Computer-supported cooperative work - Concepts and trends, AIM 2006 – Information Systems and Collaboration: State of the Art and Perspectives (AIM) **11**, 165–172 (2006)
19. Lee, R., Robbins, S.: Measuring Belongingness: The Social Connectedness and the Social Assurance Scales. Journal of Counseling Psychology **42**(2), 232–241 (1995). https://doi.org/10.1037/0022-0167.42.2.232
20. Liu, S., Smith, B.A., Vaish, R., Monroy-Hernández, A.: Understanding the Role of Context in Creating Enjoyable Co-Located Interactions. Proc. ACM Hum.-Comput. Interact **6**(CSCW1), Article 131 (2022). https://doi.org/10.1145/3512978
21. Lucena, C. J., Fuks, H., Raposo, A., Gerosa, M. A., Pimental, M.: Communication, coordination, and cooperation in computer-supported learning: The AulaNet experience. In Advances in computer-supported learning, 274–297. IGI Global. (2007) https://doi.org/10.4018/978-1-59904-355-5.ch012
22. Mashek, D., Cannaday, L.W., Tangney, J.P.: Inclusion of community in self scale: A single-item pictorial measure of community connectedness. Journal of Community Psychology **35**(2), 257–275 (2007). https://doi.org/10.1002/jcop.20146
23. Marakas, G. M.: Decision support systems in the 21st century. 1nd edn. Prentice Hall, Upper Saddle River, NJ (1998)
24. McGill, M., Williamson, J., Brewster., S. A.: How to lose friends & alienate people: sharing control of a single-user TV system. In Proceedings of the ACM International Conference on Interactive Experiences for TV and Online Video (TVX '14), pp. 147–154. Association for Computing Machinery, New York, NY, USA, (2014) https://doi.org/10.1145/2602299.2602318
25. Montecchio N, Roy P, Pachet F.: The skipping behavior of users of music streaming services and its relation to musical structure. PLoS One. **15**(9). 2020 https://doi.org/10.1371/journal.pone.0239418
26. Morris, M. R., Ryall, K., Shen, C., Forlines, C, and Vernier. F.: Beyond "social protocols": multi-user coordination policies for co-located groupware. In Proceedings of the 2004 ACM conference on Computer supported cooperative work (CSCW '04), pp. 262–265. Association for Computing Machinery, New York, NY, USA, (2004). https://doi.org/10.1145/1031607.1031648
27. Mullen, B., Copper, C.: The relation between group cohesiveness and performance: An integration. Psychological bulletin, **115**(2), (1994)
28. Neale, D. C., Carroll, J. M., Rosson, M. B.: Evaluating computer-supported cooperative work: models and frameworks. In Proceedings of the 2004 ACM conference on Computer supported cooperative work (CSCW '04), pp. 112-–121 Association for Computing Machinery, New York, NY, USA, (2004) https://doi.org/10.1145/1031607.1031626
29. O'Hara, K., Lipson, M., Jansen, M., Unger, A., Jeffries, H., Macer, P.: Jukola: democratic music choice in a public space. In Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques (DIS '04), pp. 145–154. Association for Computing Machinery, New York, NY, USA, (2004) https://doi.org/10.1145/1013115.1013136
30. Pacaux-Lemoine M. P., Flemisch, F.: Layers of Shared and Cooperative Control, assistance and automation. IFAC-PapersOnLine **49**(19), 159–164 (2016)
31. Paul, R., Drake, J.R, Liang, H.: Global Virtual Team Performance: The Effect of Coordination Effectiveness, Trust, and Team Cohesion.

IEEE Transactions on Professional Communication **59**(3), 186–202 (2016). https://doi.org/10.1109/TPC.2016.2583319
32. Park, S. Y., Laplante, A., Lee, J. H., Kaneshiro, B.: Tunes Together: Perception and Experience of Collaborative Playlists. In ISMIR, pp. 723-730. (2019)
33. Park, S.Y., Kaneshiro, B.: Social Music Curation That Works: Insights from Successful Collaborative Playlists. Proc. ACM Hum.-Comput. Interact. 5, CSCW1, Article 117 (April 2021), (2021). https://doi.org/10.1145/3449191
34. Pelled, L. H., Eisenhardt, K. M., Xin, K. R.: Exploring the black box: An analysis of work group diversity, conflict and performance. Administrative science quarterly, 44(1), 1–28. (1999)
35. Plaumann, K., Lehr, D., Rukzio, E.: Who Has the Force? Solving Conflicts for Multi User Mid-Air Gestures for TVs. In Proceedings of the ACM International Conference on Interactive Experiences for TV and Online Video (TVX '16), pp. 25-–29. Association for Computing Machinery, New York, NY, USA, (2016) https://doi.org/10.1145/2932206.2932208
36. Rama, J., Bishop, J.: A survey and comparison of CSCW groupware applications. In Proceedings of the 2006 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries (SAICSIT '06), pp. 198–205. South African Institute for Computer Scientists and Information Technologists, ZAF, (2006) https://doi.org/10.1145/1216262.1216284
37. Rock, K. S.: Social support versus companionship: effects on life stress, loneliness, and evaluations by others. Journal of personality and social psychology **52**(6), (1987)
38. Rummel, N., Spada, H.: Learning to collaborate: An instructional approach to promoting collaborative problem solving in computer-mediated settings. The journal of the Learning Sciences, **14**(2), 201–241. (2005)
39. Salomon, G., Globerson, T.: When teams do not function the way they ought to. International Journal of Educational Research **13**(1), 89–99 (1989) https://doi.org/10.1016/0883-0355(89)90018-9
40. Santos, R., Marreiros, G., Ramos, C., Neves, J., Bulas-Cruz, J.: Personality, emotion, and mood in agent-based group decision making. IEEE Intelligent Systems, **26**(06), 58-66. (2011)
41. Schrepp, M., Hinderks, A, Thomaschewski, J.: Design and Evaluation of a Short Version of the User Experience Questionnaire (UEQ-S). International Journal of Interactive Multimedia and Artificial Intelligence **4**(6), 103–108 (2017). https://doi.org/10.9781/ijimai.2017.09.001
42. Shen, C.: From Clicks to Touches: Enabling Face-to-Face Shared Social Interface on Multi-touch Tabletops. In: Schuler, D. (eds) Online Communities and Social Computing. OCSC Lecture Notes in Computer Science, vol 4564. Springer, Berlin, Heidelberg. 2007
43. Spotify, Collaborative playlists `https://support.spotify.com/us/article/collaborative-playlists/`. Last accessed 21 January 2023
44. Ward, M.K., Goodman, J.K. Irwin, J.R.: The same old song: The power of familiarity in music choice. Mark Lett **25**, 1–11, (2014) https://doi.org/10.1007/s11002-013-9238-1
45. Wongm M. M., Csíkszentmihályi, M.: Affiliation Motivation and Daily Experience: Some Issues on Gender Differences. Journal of Personality and Social Psychology **60**, 154–164 (1991)
46. Zheng, S., Apthorpe, N., Chetty, M., Feamster, N.: User Perceptions of Smart Home IoT Privacy. Proc. ACM Hum.-Comput. Interact. 2, CSCW, (2018) https://doi.org/10.1145/3274469

47. O'Hara, K., Brown, B.: Consuming Music Together Social and Collaborative Aspects of Music Consumption Technology. Springer, the Netherlands (2006)
48. Author, F.: Article title. Journal **2**(5), 99–110 (2016)
49. Author, F., Author, S.: Title of a proceedings paper. In: Editor, F., Editor, S. (eds.) CONFERENCE 2016, LNCS, vol. 9999, pp. 1–13. Springer, Heidelberg (2016). https://doi.org/10.10007/1234567890
50. Author, F., Author, S., Author, T.: Book title. 2nd edn. Publisher, Location (1999)
51. Author, A.-B.: Contribution title. In: 9th International Proceedings on Proceedings, pp. 1–2. Publisher, Location (2010)
52. LNCS Homepage, `http://www.springer.com/lncs`. Last accessed 4 Oct 2017