DISABILITY AND REHABILITATION
2025, VOL. 47, NO. 10, 2557–2571
https://doi.org/10.1080/09638288.2024.2396061

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RESEARCH ARTICLE

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Impact of adult cochlear implantation on the partner relationship: a conceptual framework informed by cochlear implant recipient and partner perceptions

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ABSTRACT

Purpose: (1) To understand the impact of adult cochlear implantation on the partner relationship, as perceived by adult cochlear implant (CI) recipients and their intimate partners. (2) To generate a conceptual framework for guiding future research and clinical adult cochlear implantation interventions.

Method: Concept mapping, a participatory, mixed-method approach, was used for data collection, analysis and interpretation. Participants attended sessions to generate, sort and rate statements describing the changes in their relationship due to cochlear implantation. Participants included 15 CI recipients (mean age: 51.6 years; SD: 8.2) and 12 partners (mean age: 50.9 years; SD: 8.2).

Results: Five concepts emerged from the data, describing changes in the partner relationship following cochlear implantation: (1) *Social Interactions*, (2) *Partner Involvement*, (3) *Communication*, (4) *Emotional Adjustment*, and (5) *Relationship Intimacy*. The concept *Relationship Intimacy* was rated the highest in positivity and importance. Findings also underscored improved social interactions, communication dynamics, and emotional adjustment.

Conclusions: The *Relationship Intimacy* cluster emerged as pivotal, highlighting its essential role in improving post-implantation relationships. CI recipients experienced enhanced autonomy, while partners' roles evolved regarding assistance and support. The diverse effects of implantation on partner relationships highlight the importance of adopting a patient- and family-centered approach to audiological intervention.

IMPLICATIONS FOR REHABILITATION

- These insights on partner relationships and cochlear implantation can inform tailored pre- and ongoing post-operative counselling to support cochlear implant recipients and their partners in navigating relationship changes, emotional adjustments, and addressing communication challenges.
- Cochlear implantation reduces partner burden, emphasising the need for hearing healthcare professionals to facilitate partner engagement in rehabilitation approaches.
- Relationship intimacy, deemed the foremost positive outcome, underscores the importance of incorporating these aspects into pre- and post-operative counselling.

ARTICLE HISTORY
Received 4 September 2023
Revised 19 August 2024
Accepted 20 August 2024

KEYWORDS
Cochlear implant; partner; patient- and family-centred care; concept mapping; counselling; relationship

Introduction

Cochlear implantation is currently the only effective method of auditory rehabilitation available for individuals presenting with bilateral severe-to-profound sensorineural hearing loss who obtain inadequate benefit from acoustic amplification [1]. Cochlear implant (CI) technology has brought about a transformative change in the field of audiology [2], offering numerous benefits such as improved speech perception [1], enhanced quality of life [3], improvement in tinnitus distress [4], cognitive enhancements [5], heightened awareness of environmental sounds [6], and increased self-confidence among adult recipients [7]. However, despite these significant advantages, a subgroup of CI recipients still experiences reduced outcomes in terms of speech perception, telephone use [8], and music appreciation [9] due to the complex processes that contribute to CI outcome variation [1].

The psychosocial features of hearing loss are multifaceted and consist of the cognitive, emotional, behavioural, physical, and interpersonal reactions to hearing loss [10]. Audiological research has confirmed that individuals with hearing loss experience a wide range of negative consequences associated with the loss of hearing, such as depression, anxiety, loneliness, lack of self-confidence, sadness, and increased use of healthcare [9,11–15]. While some cochlear implant recipients experience improvements in psychosocial well-being post-implantation, many experience persistent symptoms of psychosocial distress [16], underscoring the inadequacy of current audiological services in addressing the psychosocial needs of their clientele [17]. Although recent studies have begun to explore the integration of psychosocial interventions into audiological rehabilitation services [18,19], these endeavours have primarily focused on audiology in general, highlighting

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/09638288.2024.2396061.

the necessity for a nuanced examination of the psychosocial experiences specific to adult cochlear implant recipients.

The influence of hearing loss is widespread and extends beyond the person with hearing loss [20]. Many partners and other members of the family may face activity restrictions and constraints in participation, termed third-party disability [21]. The International Classification of Functioning, Disability and Health (ICF) [22] recognises third-party hearing disability as an environmental factor and acknowledges that family members can experience changes in functioning as a result of their significant other's hearing loss [23]. While studies have evaluated the impact of hearing loss on the individual [21,24,25], the influence on partners is underreported [23] and often separated to suggest that their experience is detached from the partner with hearing loss's experience [26]. Moreover, Kamil and Lin's [27] systematic review of the impact of hearing loss on communication partners concluded that the change in spouses' quality of life subsequently burdens their relationship. These difficulties are exacerbated in cases of severe-to-profound hearing loss [20].

Cochlear implantation not only affects the adult CI recipient, and little knowledge has been gathered specifically regarding the effect that cochlear implantation has on the partner [28,29]. Evidence suggests that partners of CI recipients may experience levels of irritation and self-assessed frustration on much the same level, if not more, as the CI recipient, and they encounter a similar decrease in activities of a social nature [30,31]. This may lead to partners feeling lonely and that their relationship has become less intimate [32].

While some partners encounter diminished social engagement and emotional wellness, others describe improved social functioning, with one study demonstrating a 60% improvement in spousal emotional state after their partner received a CI [9]. Partners described being less concerned about the safety of the CI recipient, a reduction in the need for them to act as an interpreter for their spouse, and a reduction in stress associated with caring for their partner following cochlear implantation [9]. Cochlear implantation has been found to enhance autonomy, normalcy, and social life satisfaction for CI recipients and, importantly, their partners [29].

Research on the partner relationship is important as partners can impact the motivations and decisions of adults with hearing loss [13]. A study by Ekberg et al. [33] investigated family members' participation in initial audiology consultations with adults with hearing loss and found that despite displaying a desire to participate, partners and family members were usually not invited or encouraged to participate during the appointment. However, Glade [2] revealed that every CI recipient found involving their spouse in auditory rehabilitation beneficial. Effective audiological care should go beyond implantable devices [34], embracing patient- and family-centered care (PFCC) principles [35,36]. Thus, knowledge of partners' perceptions regarding cochlear implantation may aid in the establishment of individualised rehabilitation plans that regard both parties in the circumstances of their daily demands [37]. Moreover, engaging family members in the decision-making process and educating them about expectations and the appropriate use of devices can play a crucial role in ensuring success with technologies such as CIs [38].

Although previous research has been conducted regarding the inclusion of partners in the aural rehabilitation process for individuals with hearing aids [31,39–42], limited information has been gathered specifically on the applications in the adult CI recipient population and the influence of cochlear implantation on intimate relationship dynamics. While a few studies have explored various aspects of the impact of CIs on the CI recipient and their partner, they have often had a singular focus [9] or have been a secondary finding of a somewhat related study [2]. There has not been a comprehensive exploration of the multiple factors that impact intimate relationships, nor has there been such an exploration driven by those with lived experience.

Conceptual frameworks are collections of assumptions, beliefs, and concepts used to represent real-world phenomena [43], aiding in understanding complex subjects and illustrating interrelationships not immediately apparent [44]. The development of a conceptual framework using participatory methods offers the potential to construct a comprehensive framework encompassing adult CI recipients and their partners to enrich clinical practice.

Given the current knowledge gap, this study aimed to describe the impact of adult cochlear implantation on the partner relationship as perceived by adult CI recipients and their partners. Knowledge of the effects of adult cochlear implantation on the partner relationship can inform evidence-based audiological service delivery that specifically targets increased concurrence between adult CI recipients and their partners [37], further fostering a PFCC approach. Furthermore, this study also aimed to utilise these perceptions to construct a conceptual framework to better understand the impact of adult cochlear implantation on the partner relationship to inform future research directions and clinical interventions supporting adult CI adopters.

Materials and methods

Study design

Concept mapping was followed as a participatory mixed-method research approach in this study, which involves a four-stage process to generate and analyse the data [45,46]. These stages include (1) brainstorming, (2) grouping and rating, (3) data analysis, and (4) interpretation. Concept mapping methods were used to produce a conceptual framework for understanding the impact that adult cochlear implantation has on the partner relationship from the perspectives of adult CI recipients and their partners. This approach combines qualitative and quantitative group or individual techniques for data collection; while employing quantitative analysis techniques, visual maps are generated to depict how individuals perceive the subject under investigation [47–49]. Concept mapping facilitates the engagement of multiple stakeholders across the entirety of the process, leading to a coherent model of how the concepts and ideas generated are interrelated [50]. In addition, concept mapping allows patients to efficiently engage in defining research goals and permits better comprehension of the patient experience in the context of disease and health [51].

Concept mapping techniques are increasingly being used to evaluate and improve healthcare systems and outcomes [47,52–55], as well as in the field of audiology [56–59]. A collaborative, mixed-method approach such as concept mapping effectively overcomes the time and resource constraints associated with individual interviews and focus groups [51]. A methodological approach was needed in this study that enabled participants to engage in a manner and time convenient for them, further enabling a PFCC approach to adult cochlear implantation. In addition, considering the limited available knowledge on the lived experiences of adult CI recipients and their partners, concept mapping can empower individuals to elicit diverse opinions regarding adult cochlear implantation and actively engage in data analysis. Hence, participant involvement significantly minimises potential researcher bias and interference in data analysis and its outcomes. The resulting conceptual framework can also be used to plan improvements and evaluate CI service delivery [49].

During brainstorming, individual participants are required to produce statements in response to the focus question. The objective of brainstorming is to generate a varied and rich statement set that constitutes the entire conceptual scope of the subject matter [48], in this context, CI recipients and their partners. Grouping entails participants sorting statements into piles based on perceived similarities and assigning labels to each pile reflecting its contents. Thereafter, each participant rated every statement against a Likert scale. These steps permit participants to put forth their perspectives and experiences without predetermined boundaries and restrictions from researcher examples, classifications, or descriptions [47,60].

Analysis of the data by means of quantitative approaches (i.e., hierarchal cluster analysis and multidimensional scaling) allows for the representation of the results in the form of interpretable pictorial views of how the sorting and rating data are interrelated [50,59]. The participants give rise to identifying connections and themes, while researchers ascertain the number of themes that effectively represent participants' data [45]. Following this method enhances the validity of research findings in comparison to other qualitative methodologies [60].

Table 1. Demographic information for cochlear implant recipients and partners.

Demographic variable	CI recipients $n=15$	Partners $n=12$
Age (years)		
Mean (SD)	51.6 (8.2)	50.9 (8.1)
Min–Max	34–64	34–60
Sex, n (%)		
Male	9 (60)	3 (25)
Female	6 (40)	9 (75)
Highest qualification, n (%)		
Primary/high school (< grade 12)	1 (6.7)	2 (16.6)
Secondary (grade 12) completed	5 (33.3)	2 (16.6)
Tertiary qualification (university)	7 (46.7)	3 (25.0)
Tertiary qualification (other)	2 (13.3)	4 (13.3)
No response	–	1 (8.3)
Employment status, n (%)		
Employed full-time	11 (73.3)	7 (58.3)
Employed part-time	–	–
Self-employed full-time	2 (13.3)	1 (8.3)
Self-employed part-time	–	–
Retired	1 (6.7)	1 (8.3)
Unemployed	1 (6.7)	3 (25)
Type of CI fitting, n (%)		
Unilateral (no hearing aid in non-implanted ear)	4 (26.7)	
Bilateral	4 (26.7)	
Bimodal (hearing aid in non-implanted ear)	7 (46.7)	
Duration of CI use (years)*		
Mean (SD)	4.0 (3.5)	
Min–Max	1–15	
Hearing screening inventory** (Coren & Hakstian, 1992), n (%)		
Normal		8 (66.7)
≥25 dB		2 (16.7)
≥55 dB		2 (16.7)

Note.
*Calculated from the date of first CI activation to the date of first data collection session.
**The screening instrument consists of 12 self-report hearing-related items with graded responses ('never' to 'always' for questions 1 to 8 and 'good' to 'very poor' for questions 9 to 12). The score is obtained by summing the responses. Scores are linked to hearing status categories and predict best ear hearing sensitivity: 12 to 27 = normal hearing, 28 to 37 = 25 dB or more hearing loss, and ≥38 = 55 dB or more hearing loss [92% prediction accuracy (Coren & Hakstian, 1992)].

Participants

The term "partner" extends beyond a legal spousal relationship and encompasses an ongoing, mutually influential connection between individuals, irrespective of traditional gender roles [61]. Within the context of this study, we defined partners as couples living together in an intimate relationship.

This study consisted of two participant cohorts:1) CI recipients and 2) their partners. Both cohorts were recruited from two CI centres in South Africa. Non-probability, purposive sampling was used to include diverse individuals [48]. Participants were proficient in English in order to comply with the software requirements for data collection procedures, and those choosing online data collection required internet, computer, and email access. CI recipients, with a minimum of 12 months experience with a CI, who were post-lingually deafened and oral communicators, were included. Limiting participants to post-lingually deafened oral communicators ensured adherence to concept mapping data collection procedures and reduced the risk of communication barriers between participants and researchers. Partners had daily interaction and cohabited with the CI recipient for at least 12 months pre-implantation.

Adult participants aged 19 to 65 years at the time of data collection were recruited for the study. The focus was on adults aged 65 and younger to explore the experiences of those still in an active phase of life, e.g., with working-age experiences or young family commitments, contrasting with retired older adults [62]. The lived experience of younger or working adults would be different from that of older adults in the context of their daily demands and circumstances, and hence, the latter were excluded. All participants indicated their relationship status as "married". The study population's characteristics are outlined in Table 1 in terms of the two cohorts.

Procedures

Ethical approval for this study was obtained by the *Research Ethics Committee of the Faculty of Humanities* at the University of Pretoria (HUM017/1220). All participants were required to complete a self-reported demographic questionnaire in hard or soft copy (*via* email) before the brainstorming sessions. Partners also completed the *Hearing Screening Inventory* [63] to capture their self-reported hearing status and to describe the partner cohort in terms of hearing status. The *Hearing Screening Inventory* was used to predict pure-tone audiometric outcomes as opposed to quantifying the perceived handicap in the social, occupational, behavioural, and communication domains. Validity coefficients of 0.80 have been produced in relation to pure-tone thresholds [63].

Brainstorming

Brainstorming sessions occurred during two in-person group sessions ($n=6$), multiple in-person individual sessions ($n=5$), and online individual sessions ($n=9$). According to Trochim [48], employing 10 to 20 individuals in brainstorming is sufficient in order to elicit diverse opinions. CI recipients and partners were separated when participating in brainstorming so that participants may feel comfortable discussing their perceptions and experiences about the other group and speak freely without considering the other party [45]. Brainstorming sessions commenced by presenting the study's aim, a description of what constitutes a partner relationship for the purpose of this study, and how the brainstorming was to be conducted. The sessions were not recorded. Online platforms were also utilised due to COVID-19 safety precautions

and to accommodate participants from various geographical locations. Employing different modes of engagement for brainstorming in a study's design has no adverse impact on the generated concept map's validity and reliability [52].

Brainstorming commenced with a "warm-up" question (Table 2) to familiarise participants with the brainstorming process and filter irrelevant information that does not pertain to the topic of interest (not used for data analysis). The focus question (Table 2) was carefully constructed for the purpose of this study. Both cohorts were asked to generate statements that described the change in their relationship since cochlear implantation. The questions were posed in an impartial manner, and prompts were used when there was a lull in contributions and to ask participants for clarification when a statement was unclear.

Statements provided by participants were recorded on a Microsoft Excel sheet and displayed on a screen during all brainstorming sessions. Statements provided in Afrikaans were immediately translated into English, and the researcher subsequently asked the participants to verify if the translation accurately conveyed the intended meaning. Participants were requested to provide as many statements as they saw fit, and there was no discussion or criticism related to the legitimacy of their statements during the sessions [48]. Brainstorming ceased when data saturation was reached, as indicated by the fact that no novel statements were put forth and a slow response rate by participants [64]. Online brainstorming was conducted with eleven participants, and in-person brainstorming was conducted with nine participants ($n = 20$), which is considered satisfactory [48].

Once brainstorming was completed, the research team (C.L., T.I.R., R.B.; R.E.) pooled and refined all generated statements (264 raw statements). All statements were edited to be written in the third person so that both cohorts could use and interpret them during the subsequent grouping and rating tasks. During the refining process, statements were edited to keep with participants' original wording as much as possible. The researchers examined the set of statements for editing considerations (Supplementary Table S1): to remove irrelevant statements, ensure that all statements are sufficiently detailed so that every member of the group will understand the meaning [48], eliminate any grammatical, spelling or duplicate errors [53], and ensure anonymity. This process yielded 110 final statements.

Table 2. Questions presented during brainstorming sessions.

	CI recipients	Partners
'Warm-up' question	*"Think back to a time before you received your cochlear implant(s)… how did your hearing loss impact your relationship with your partner?"*	*"Think back to a time before your partner received their cochlear implant(s)… how did their hearing loss impact your relationship with them?"*
Focus question	*"In terms of your relationship with your partner, what has changed since you received your cochlear implant(s)?"*	*In terms of your relationship with your partner, what has changed since they received their cochlear implant(s)?"*
Prompt	*"In my opinion, since I received my cochlear implant(s), my relationship with my partner has changed in terms of…"*	*"In my opinion, since my partner received their cochlear implant(s), my relationship with them has changed in terms of…"*

Grouping and rating

After the brainstormed statements were refined, a final combined statement list was uploaded onto the *groupwisdom*™ Concept Systems software [65], with the order of statements randomised for each participant. Once individuals agreed to participate in the tasks, they were sent an email containing instructions and a link to the grouping and rating webpage. The webpage included clear and thorough instructions on completing grouping and rating. Both cohorts participated in the grouping and rating tasks.

Participants were instructed to organise the statements according to their interpretation of the relationships between them and their similarities. Participants were able to form as many piles as they saw fit but had to ensure that (1) each statement could only be sorted into one group, (2) each group should contain one or more statements, and (3) all groups could not consist of only one statement [48]. Should a statement not fit into any of the existing groups, it could form a group on its own, i.e., if there were single statements that participants felt did not fit within any other group, they may be left isolated in their "own group" [48]. Participants were instructed to label their piles with a unique label that reflects each pile's contents. They were instructed not to create any groups with the labels "miscellaneous," "other," "not applicable," "true," "false," or any other generic name.

Participants were presented with two rating questions, which included a list of statements describing potential changes in a couple's relationship following cochlear implantation. The first was, "*Please indicate how much of an effect each of these aspects may have on a couple's relationship*", where each statement was rated against a 5-point Likert scale: 1 = extreme negative effect to 5 = extreme positive effect. In the second question, participants were to reflect on their past decision-making process to proceed with cochlear implantation and the information that they considered helpful. The question asked, "*Please rate how important it is for future cochlear implant recipients and their partners to be made aware of these potential relationship changes when deciding whether to get a cochlear implant or not*", and was rated against a 5-point Likert scale: 1 = minimally important to 5 = extremely important.

All 20 individuals who participated in brainstorming were invited *via* email to complete the grouping and rating tasks; however, four of these participants declined. An additional round of participant recruitment was conducted to include individuals who had not participated in brainstorming and to increase participant numbers for the grouping and rating tasks. Four participants recruited after brainstorming withdrew from the study during the grouping and rating phase. There are no detrimental effects on the resulting data when different participants complete brainstorming, grouping, or rating [50]. Eight of the 20 participants who completed brainstorming completed grouping and rating (40% retention). An additional 13 individuals were invited to participate in grouping and rating in a manner (in-person or online) that suited them, and the researcher offered assistance to each participant. However, only seven (of the 13) individuals successfully completed the tasks. A flow chart of participant recruitment can be found in Supplementary Figure S2.

Overall, 15 completed grouping, and 19 participants completed the rating activity, which is considered satisfactory for generating reliable concept maps as informed by the stress value [52]. Most participants completed the grouping and rating tasks *via* the *groupwisdom*™ Concept Systems Software (Concept Systems, Inc. Copyright 2004–2023; all rights reserved). A few participants ($n = 8$) completed the grouping task with the help of the researcher either in-person or *via* an online meeting. The participants who were assisted completed hard or soft copy versions of the rating

questions, and the researcher entered their rating data into the *groupwisdom*™ platform afterwards.

Data analysis and interpretation

The demographics of the study population were analysed using descriptive statistics. Brainstorming, grouping, and rating data were analysed *via* the *groupwisdom*™ Concept Systems Software. The first step in concept mapping data analysis is grouping (clustering) [54]. The software used a similarity matrix and multidimensional scaling to combine all participants' grouping data to generate a point map [66]. Point maps graphically display the location of individual statements in a two-dimensional space as a single point [50].

The proximity of each point represents how frequently these statements were grouped. Statements closer in proximity (sorted together more often) are more related, and statements more distant from each other (sorted together less often) illustrate different concepts [50]. A stress index was calculated to assess the goodness of fit for the multidimensional scaling analysis and to achieve internal representational validity. This index indicates how well the statement arrangement compares with the sorting data, with an acceptable range for the stress value being from 0.205 to 0.365 [67]. Internal representational validity pertains to how accurately the conceptual model reflects the participants' judgments in organising information to create the model [68].

Hierarchical cluster analysis used data from the multidimensional scaling analysis and produced cluster maps based on the grouping data. The map displays the original statements confined by polygon-shaped borders [50]. The research team examined various configurations of the clusters to determine which map was the best representation of the data, informed by examining the statements within each cluster and considering the bridging scores between clusters. A higher bridging score indicates that statements were grouped together less frequently and are likely related to different clusters across the map [60]. Low bridging scores indicate that statements were more frequently sorted together [45]. However, the research team solely determined the cluster count, while participants independently established the hierarchical structure [60]. The researchers determined the final cluster labels together by considering the statements and pre-existing labels (provided by participants) contained in each cluster.

Reliability estimates were calculated for the final combined cluster map by randomly dividing all participants into two groups. Separate concept maps and similarity matrices were then generated for every group. A split-half reliability test was done to determine whether the concept maps significantly differed using the *groupwisdom*™ Concept Systems software and Spearman-Brown correction correlation utilising IBM SPSS Statistics [Version 28.0.1.0 (142)]. The split-half reliability test assesses the coherence of participant input, providing an indication of the concepts' reliability [52]. A correlation greater than 0.70 is considered high [69] and reveals adequate consistency between the groups, allowing for the use of one final concept map.

To further achieve internal representational validity and conduct member checking, the final cluster map with a description was presented to the participants *via* email [45]. Participants were encouraged to provide feedback and commentary regarding (1) whether the statements in each cluster reasonably represented the concepts on the map, (2) whether the labels and descriptions of each cluster accurately depicted the statements therein, and (3) whether the statements within each cluster represented the same subject matter.

In order to determine the rating data's reliability and establish internal consistency, Cronbach's Alpha was calculated for participants' rating data within each cluster [52] using IBM SPSS. To perform domain-level (cluster) rating analysis, pattern-matching graphs were generated for both questions. The average cluster ratings for each cohort were compared using a ladder-style graph to illustrate where participants rated statements differently or similarly. Welch's *t* test was calculated to compare the mean ratings among clusters. The critical *p* value used to indicate a significant difference was <0.05. Go-zone graphs allow for analysis at the item level and are generated to illustrate the rating data for each statement [53]. The graph is sectioned into four quadrants according to the statements' mean rating for both cohorts. Ratings for the statements were then placed together according to whether their rating was above or below the average rating of that cluster. Statements with similar ratings (for both cohorts), as opposed to dissimilar ratings, could be ascertained and allowed for identifying statements that were perceived to be most impactful in terms of positivity versus negativity and importance.

Results

Brainstorming

A total of 264 raw statements were generated from both cohorts describing the impact of adult cochlear implantation on the partner relationship. After editing and refining, 110 statements remained (Supplementary Table S3), containing 58 statements generated by the CI recipient cohort and 52 by the partner cohort. The inclusion of a diverse sample of participants, including variations in gender, age, and CI fitting type (Table 1), ensured that a broad range of experiences was captured. A sub-set of the statements is indicated in Table 3.

Grouping and rating

In total, 21 individuals participated in the grouping activity. However, three (1 CI recipient; 2 partners) withdrew from the study before their grouping tasks were completed. Although participants were clearly instructed not to create groups such as "miscellaneous," "other," "not applicable," "true," "false," or any other generic name, three participants did create such groups (2 CI recipients; 1 partner), even after asking them to revise. Their grouping data was excluded from the grouping analysis as it did not represent grouping based on similarities between statements. Therefore, the final concept map utilised the grouping data of 15 participants (9 CI recipients; 6 partners) in order to ensure satisfactory reliability estimates [52]. The number of clusters formed by participants was between four and ten (mean 6, SD 1.58; mode 5).

When all participants were combined and then randomly divided into two groups, the split-half correlation for the grouping data was 0.78 when applying the Spearman-Brown correction, indicating agreement between how participants sorted the data. The final combined concept map produced a stress index of 0.247, signifying a strong alignment between the concept map and similarity matrix [67]. Additionally, the elevated stress index achieved by the resultant map signifies the robust reliability of the concept map in relation to the grouping data generated by each participant.

The researchers examined various cluster solution options. A 4-cluster solution merged clearly distinct concepts and yielded groups with high bridging averages that were conceptually too broad. A 6-cluster solution only divided the *Communication* cluster

Table 3. Five concepts describing the impact of adult cochlear implantation on the partner relationship with a subset of the generated statements.

Concept (bridging average)	Description	Statements (bridging scores)
Social Interactions (0.8)	Aspects relating to social activities, the listening environment and practical changes made by the couple.	1. The partner of the cochlear implant recipient had to learn to be more social again after cochlear implantation (0.65) 12. Since cochlear implantation, it is much better to go to the movies together as a couple (0.95) 14. As a couple, we can now go out with friends together (0.99) 15. As a couple, we don't have to be cognizant of where we go or where we sit anymore (0.92)
Partner Involvement (0.68)	Aspects relating to assistance provided to the CI recipient, accommodations made by the partner and how the couple functions in their environment.	7. In terms of logistical aspects, partners have to adjust after cochlear implantation, like positioning themselves on the side where the cochlear implant recipient can hear better (0.74) 8. There are practical things that would still be very difficult for the cochlear implant recipient to do alone where they need their partner's help, for example, having a conversation with an unfamiliar person over the phone (0.80) 24. The partner no longer has to act as the "middle-man" or interpreter between the cochlear implant recipient and others (0.70) 61. The cochlear implant recipient still asks their partner to help them in difficult listening situations or if they don't have their cochlear implant(s) on (0.74)
Communication (0.52)	Aspects relating to communication between the couple and between the CI recipient and those around them.	32. There are a lot less misunderstandings between us after cochlear implantation (0.49) 33. At home, the children now include the cochlear implant recipient in conversations; it's no longer only between them and the hearing partner (0.51) 56. Since cochlear implantation, there are still some misunderstandings and difficulties during communication (0.72) 93. The cochlear implant recipient is much more interactive and talkative in conversations since cochlear implantation (0.62)
Emotional Adjustment (0.54)	Positive and negative emotions experienced by both partners after cochlear implantation.	2. Emotionally, the partner has become more sensitive to the cochlear implant recipient's needs after cochlear implantation (0.39) 17. Following cochlear implantation, the cochlear implant recipient can take their stand in the house again and don't have to rely so much on their partner (0.60) 23. The partner is very accommodating and helped the cochlear implant recipient a lot to adjust after implantation (0.48) 99. As a couple, we had to adjust to the fact that the partner with the cochlear implant is now seen by others as a person with a disability (0.93)
Relationship Intimacy (0.1)	How cochlear implantation impacted the couples' relationships with each other.	22. There is a partnership between the couple in order for the cochlear implant recipient to hear well (0.18) 38. Because communication is easier, couples are less frustrated with each other (0.17) 50. Cochlear implantation has done wonders for us as a couple (0.00) 107. The improvement in a couple's relationship makes cochlear implantation worthwhile (0.02)

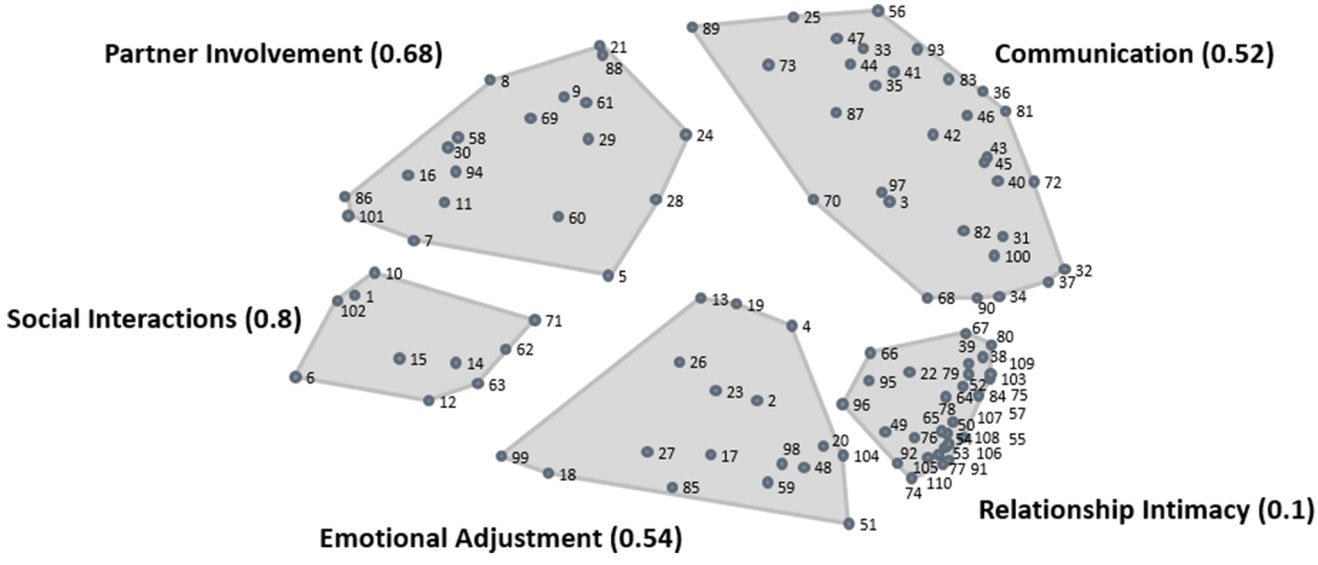

Figure 1. Concept map depicting the five clusters that describe the impact of cochlear implantation on the partner relationship. The bridging scores (indicated in brackets) illustrate how frequently participants grouped those statements, where a lower score indicates that statements were grouped in that cluster more frequently. The small numbers represent the individual statements (Table S3).

into two with no clear distinction between the statements contained in the two clusters. Thus, the final map encompassed five concepts related to what has changed in terms of their relationship with their partner since cochlear implantation: (1) *Social Interactions*, (2) *Partner Involvement*, (3) *Communication*, (4) *Emotional Adjustment*, and (5) *Relationship Intimacy* (Figure 1). The bridging scores ranged from 0.1 to 0.8, with the cluster *Social Interactions* being the most conceptually broad and the cluster

Relationship Intimacy being the narrowest. The concept map exhibited five distinct concepts derived from the participants' grouping data, demonstrating separate and evenly spaced groups without overlap. This observation suggests a general consensus among participants regarding the grouping of statements, as well as their recognition of the unique nature of each concept. None of the participants expressed disagreement or proposed any modifications regarding the final concept map when asked to provide feedback *via* email. However, one participant remarked that the *Social Interactions* cluster is surprisingly small compared to the other four clusters. In response to this comment, the original set of raw statements was reviewed to explore the proportion of statements relating to social interaction. There appeared to be fewer statements relating to social and environmental aspects compared to the other four clusters. Thus, this initial scarcity of statements accounts for the reduced cluster size.

Reliability

Nineteen participants (11 CI recipients; 8 partners) completed the rating activity. Cronbach's α revealed high intercorrelation and internal consistency overall for both rating scales: positivity/negativity (α = 0.967) and importance (α = 0.978).

Positivity/negativity ratings. The reliability assessments (Table 4) of the rating data exhibited high, good, and acceptable levels of internal consistency [70] for all four clusters except the *Emotional Adjustment* cluster for the positivity/negativity rating. Reliability estimates for the cluster *Emotional Adjustment* improved to 0.5 and above when statements 27, 59, 98, or 99 were removed from the item set used for Cronbach's analysis. Due to the inherent emotional nature of these statements, participants might have disagreed on ratings and interpreted them differently, reflecting their varied experiences. While the pattern matching graph provides a visual representation comparing the cluster means, the go-zone may be consulted to examine these statements (27, 59, 98, and 99) as it plots each individual statement according to participants' ratings [45].

Table 4. Reliability assessments of the rating data using Cronbach's alpha (α) for the positivity/negativity and importance ratings for both cohorts in each cluster.

Cluster	Positivity/negativity Cronbach's α	Importance Cronbach's α
Relationship intimacy	α = 0.963	α = 0.968
Communication	α = 0.923	α = 0.940
Partner involvement	α = 0.741	α = 0.850
Social interactions	α = 0.737	α = 0.639
Emotional adjustment	α = 0.469	α = 0.762

Importance ratings. Reliability assessments (Table 4) of the rating data exhibited high, good, and acceptable levels of internal consistency [70] for all five clusters for the importance rating. Statistically significant distinctions, evaluated through Welch's *t* test, were not observed between the cohorts' assessments of each cluster for both questions. The average positivity/negativity and importance ratings of each cluster can be found in Supplementary Table S4.

Comparing cohorts

The pattern matching graph for participants' ratings for each cluster shows the positive or negative effect that these changes had on the partner relationship (Figure 2). Overall, all clusters had an average cluster rating above three from both cohorts, indicating that no cluster had a negative effect on their relationship. Visual examination of the graph could indicate that partners assigned a lower rating to the *Partner Involvement* cluster, suggesting a more negative effect on their relationship in comparison to CI recipients. Similarly, visual inspection suggests that CI recipients rated the cluster *Emotional Adjustment* lower than partners. However, there were no statistically significant differences between the cohorts' average ratings of any of the five clusters. Both cohorts rated the aspects contained within the *Relationship Intimacy* cluster as having the most positive effect on a couples' relationship (statistically significant), with an average (combined) rating of 4.04.

CI recipients indicated that the *Relationship Intimacy* cluster had a statistically significantly greater positive effect on a couple's relationship than *Social Interactions* [t (41) = 4.056, $p = 0.0001$], *Partner Involvement* [t (50) = 4.769, $p < 0.001$], and *Emotional*

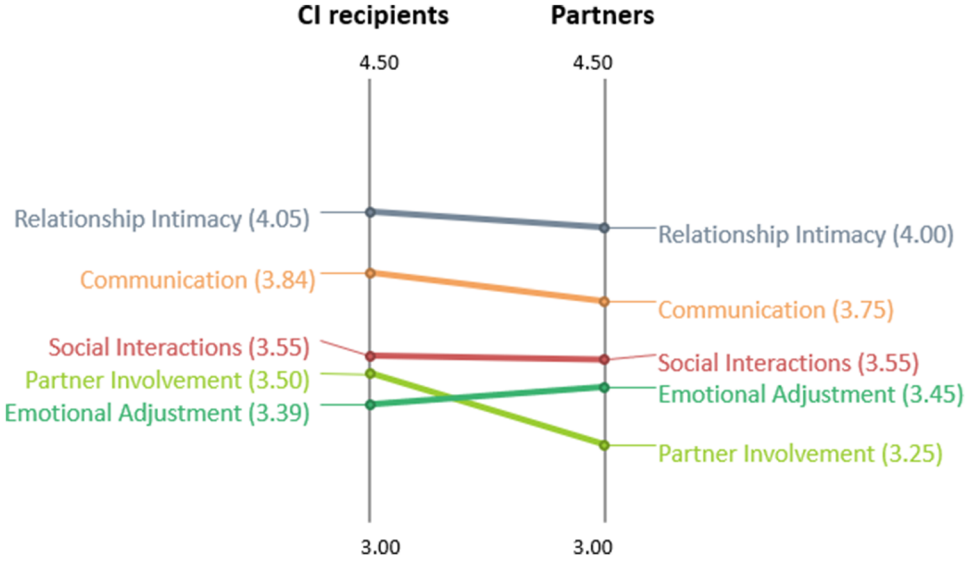

Figure 2. Pattern matching comparing CI recipients' and partners' ratings of the positivity/negativity of the changes in a couple's relationship (1 = extreme negative effect; 5 = extreme positive effect). The average cohort rating for each concept is displayed in brackets.

Table 5. Welch's *t* test used to determine significant differences between the average ratings for the positive/negative effect on a couple's relationship of each cluster for both cohorts.

	CI recipients [Welch's *t* (degrees of freedom), *p* value				Partners [Welch's *t* (degrees of freedom), *p* value]			
Cluster	1. Social interactions	2. Partner involvement	3. Communication	4. Emotional adjustment	1. Social interactions	2. Partner involvement	3. Communication	4. Emotional adjustment
2. Partner involvement	0.41 (27), $p = 0.3430$				1.76 (27), $p = 0.0453$			
3. Communication	1.78 (39), $p = 0.0414$	2.22 (48), $p = 0.0155$*			1.17 (39), $p = 0.1238$	2.98 (48), $p = 0.0026$*		
4. Emotional adjustment	0.94 (25), $p = 0.1769$	0.61 (34), $p = 0.2721$	2.48 (46), $p = 0.0085$*		0.46 (25), $p = 0.3242$	0.99 (34), $p = 0.1630$	1.45 (46), $p = 0.0768$	
5. Relationship intimacy	4.06 (41), $p = 0.0001$*	4.76 (50), $p < 0.001$*	2.02 (62), $p = 0.0534$	4.39 (48), $p < 0.001$*	3.57 (41), $p = 0.0005$*	6.19 (50), $p < 0.001$*	2.03 (62), $p = 0.0235$*	3.26 (48), $p = 0.001$*

Note. Performed separately for each cohort.
Statistically significant for $p < 0.05$*.

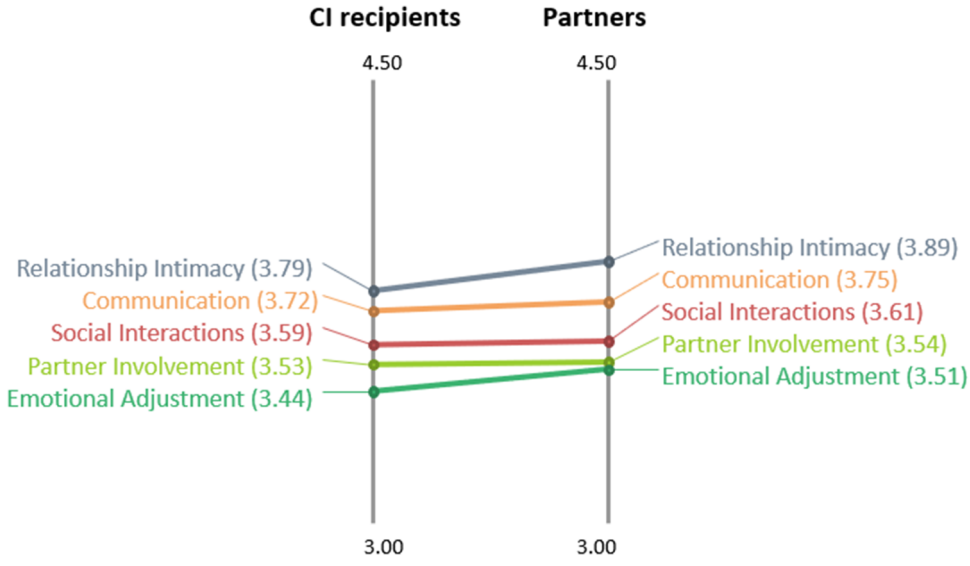

Figure 3. Pattern matching graph comparing CI recipients' and partners' ratings of the importance of the changes in a couple's relationship (1 = minimally important; 5 = extremely important). The average cohort rating for each cluster is displayed in brackets.

Adjustment [*t* (48) = 4.394, $p < 0.001$]. The *Communication* cluster had a statistically significantly more positive effect than *Partner Involvement* [*t* (48) = 2.2213, $p = 0.0155$] and *Emotional Adjustment* [*t* (46) = 2.4768, $p = 0.0085$] according to CI recipients' ratings. Likewise, partners indicated that the *Relationship Intimacy* cluster had a statistically significantly greater positive effect on a couple's relationship than *Social Interactions* [*t* (41) = 3.571 $p = 0.0005$], *Partner Involvement* [*t* (50) = 6.186, $p < 0.001$], *Communication* [*t* (62) = 2.027, $p = 0.0235$] and *Emotional Adjustment* [*t* (48) = 3.262, $p = 0.001$]. The *Communication* cluster had a statistically significantly more positive effect than *Partner Involvement* [*t* (48) = 2.9768, $p = 0.0026$] according to partners' ratings. There were no other statistically significant differences in the rankings of the clusters for both cohorts. Table 5 depicts the statistically significant differences in the rankings of the clusters for both cohorts.

The pattern matching graph of the participants' ratings shows the relative importance of each cluster (Figure 3). Visual inspection may suggest that partners rated the cluster *Relationship Intimacy* higher, meaning more important than CI recipients. Similarly, visual examination of the graph could indicate that CI recipients rated the cluster *Emotional Adjustment* lower, meaning less important than partners. However, there were no statistically significant differences between the cohorts for the average ratings for any of the five clusters. Although all five clusters were rated similarly high in terms of importance, aspects contained within the *Relationship Intimacy* cluster were deemed most important, with an average (combined) rating of 3.83. Both cohorts rated the *Relationship Intimacy* cluster as more important than the other four clusters, with statistically significant differences.

CI recipients rated the *Relationship Intimacy* cluster as more important than *Partner Involvement* [*t* (50) = 2.47, $p = 0.0086$] and *Emotional Adjustment* [*t* (48) = 2.79, $p = 0.0037$]. Partners also rated the *Relationship Intimacy* cluster as more important than *Partner Involvement* [*t* (50) = 3.67, $p = 0.0003$] and *Emotional Adjustment* [*t* (48) = 2.64, $p = 0.0056$]. There were no other statistically significant differences in the rankings of the clusters for both cohorts. Table 6 depicts the statistically significant differences in the rankings of the clusters for both cohorts.

Comparing rating questions

The Go-Zone graph illustrates the ratings of both cohorts of the changes according to positive/negative effect and importance (Figure 4). The bottom left quadrant contained 31 statements (31/110, 28.2%) largely originating from the *Emotional Adjustment* cluster (9/31, 29%) and *Partner Involvement* cluster (8/31, 25.8%), indicating that those changes were deemed to have a more negative effect on couples' relationships but had lower importance. The bottom right quadrant contained 16 statements (16/110, 14.5%) largely originating from the *Relationship Intimacy* cluster (6/16, 37.5%) and *Partner Involvement* cluster (4/16, 25%), indicating that these changes had a positive effect on couples' relationships but had lower importance.

Table 6. Welch's *t* test used to determine significant differences between the average ratings for importance of each cluster for both cohorts.

	CI recipients [Welch's *t* (degrees of freedom), *p* value]				Partners [Welch's *t* (degrees of freedom), *p* value]			
Cluster	1. Social interactions	2. Partner involvement	3. Communication	4. Emotional adjustment	1. Social interactions	2. Partner involvement	3. Communication	4. Emotional adjustment
2.Partner involvement	0.50 (27), $p=0.3122$				0.47 (27), $p=0.3199$			
3.Communication	0.84 (39), $p=0.2029$	1.50 (48), $p=0.0697$			0.81 (39), $p=0.2114$	1.65 (48), $p=0.0527$		
4.Emotional adjustment	1.04 (25), $p=0.1543$	0.65 (34), $p=0.2600$	1.97 (46), $p=0.0276$		0.52 (25), $p=0.3021$	0.16 (34), $p=0.4359$	1.42 (46), $p=0.0814$	
5.Relationship intimacy	1.54 (41), $p=0.0657$	2.47 (50), $p=0.0086$*	0.69 (62), $p=0.2464$	2.79 (48), $p=0.0037$*	1.92 (41), $p=0.0311$	3.67 (50), $p=0.0003$*	1.27 (62), $p=0.1049$	2.64 (48), $p=0.0056$*

Note. Performed separately for each cohort.
Statistically significant for $p<0.05$*.

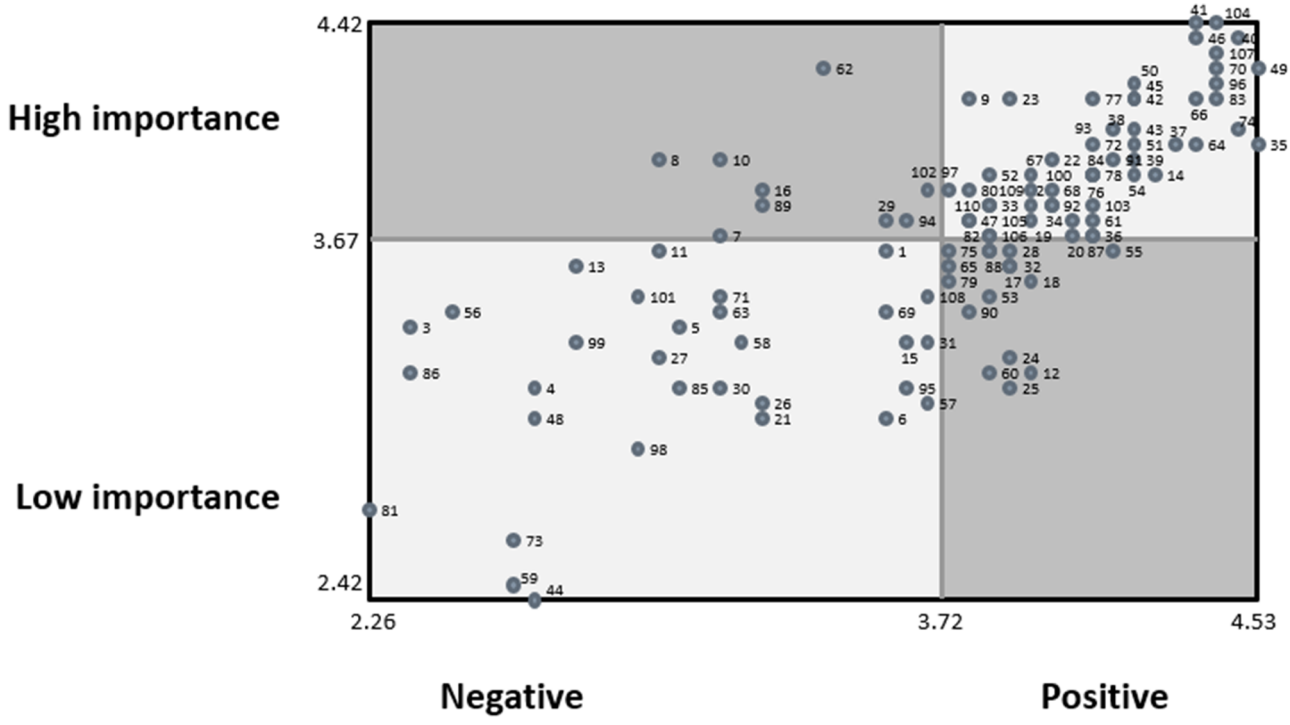

Figure 4. Go-zone graph illustrating participants' importance ratings against positive/negative effect ratings for each statement.

The top left quadrant contained nine statements (9/110, 8.2%) largely originating from the *Partner Involvement* cluster (5/9, 55.6%) and *Social Interactions* cluster (3/9, 33.3%), indicating that these changes had a more negative effect on couples' relationships and were deemed important. Most statements (54/110, 49.1%) are contained within the top right quadrant, indicating that most changes positively affected couples' relationships and are important to be made aware of. These statements are contained in the *Emotional Adjustment* cluster (5/54, 9.3%), *Partner Involvement* cluster (2/54, 3.7%), *Social Interactions* cluster (1/54, 1.9%), *Communication* cluster (21/54, 38.9%), and *Relationship Intimacy* cluster (25/54, 46.3%). It should be noted, however, that most statements (74/110, 67.3%) had a high positive average rating of the effect on a couples' relationship as opposed to only four statements that had a negative (low average rating) effect (32/110, 29.1% statements were rated as "neutral/no effect"). Similarly, most statements had a high average importance rating and were deemed important to be made aware of when deciding whether to proceed with cochlear implantation or not (70/110, 63.6%). This is also illustrated by Figure 4's ~2.2 to 4.5 scale on both axes. The number of statements that received a high (4 or 5), neutral [3], or low (1 or 2) rating were calculated manually.

While Figure 1 presents a cluster map illustrating how participants grouped individual statements and depicting the five key concepts identified, Figure 5 offers a conceptual framework that combines cluster data with rating data. In this conceptual framework (Figure 5), the size of the circles reflects the weight of the rating data, with larger circles indicating higher ratings of importance and positivity. This figure highlights the significance of relationship intimacy, which emerges as the most impactful factor on couples' relationships.

Discussion

The purpose of this study was to increase our understanding of the impact that cochlear implantation has on the partner relationship from the perspectives of adult CI recipients and their partners. The resulting conceptual framework calls attention to five concepts of the partner relationship affected by cochlear implantation: (1) *Social Interactions,* (2) *Partner Involvement,* (3) *Communication,* (4) *Emotional Adjustment*, and (5) *Relationship Intimacy.* Each will be discussed below.

Statements within the *Social Interactions* cluster describe how couples no longer have to be as mindful of the listening

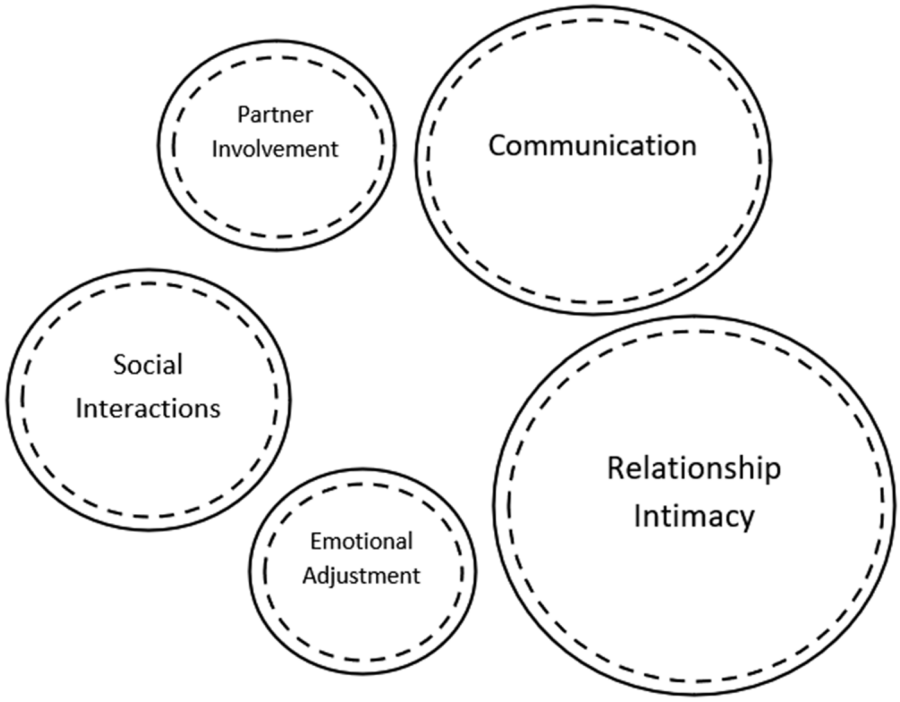

Figure 5. Visual representation of the conceptual framework illustrating five concepts that describe the impact of adult cochlear implantation on the partner relationship. The size of each concept represents the positivity/negativity (dash) and importance (solid) rating data for both cohorts combined, where a larger concept represents a higher rating of positivity and importance.

environment or seating arrangements when in social situations as they were prior to cochlear implantation. While acknowledging the hearing-related benefits of the CI(s), partners also appreciated the increased involvement in daily life activities and social interactions facilitated by the CI(s). These findings corroborate with results from Glade [2], wherein adult CI recipients described enhanced social interaction when describing post-cochlear implant life. Moreover, the present study's findings have revealed that cochlear implantation has the potential to alleviate the social challenges described by individuals with hearing loss and their spouses in a study by Govender et al. [32], i.e., avoidance of noisy environments, lack of participation in social gatherings and no longer attending movies with their partner. Participants in the present study specifically highlighted vast improvements in the aforementioned challenges. Haslam et al. [71] found that maintaining social connections acts as a safeguard for one's health and overall well-being, with a direct correlation to longevity.

In this study, both cohorts indicated a positive increase in their social life overall, and most CI recipients indicated that they are able to navigate social situations independently. Chen et al. [9] assessed the quality of life and psychosocial impact of cochlear implantation in CI recipients and their partners during their follow-up appointments. Of significance, partners observed a favourable shift in their social interactions, whereas CI recipients' responses indicated considerable variability in the enhancement or improvement regarding their hearing no longer limiting their social activities [9]. Incorporating a couple's social engagements and interests into post-operative counselling may improve a couple's functioning, as per Turton et al.'s [34] clinical recommendations.

The cluster *Partner Involvement* highlights the assistance and support that partners offer to the CI recipient. Moreover, some partners have been tasked with new responsibilities, for example, indicating the direction of where a sound comes from and making sure that the CI recipient is prepared in terms of batteries when they leave the house. In line with the findings of the present study, Barker et al. [13] found that the introduction of hearing aids leads to an intricate re-evaluation of a couple's activity limitations and responsibilities, creating its own set of difficulties for partners and individuals with hearing loss. Relationships have a significant role in mitigating the impact of hearing loss, but at times, it can come at a cost to the supportive partner. A drawback of unilateral cochlear implantation reported by Kennedy et al. [7] was that the CI recipient requested significant others to sit on the side of the CI when communicating, especially when background noise was present. The current study's findings provide further detail to this growing body of work in that participants described the breadth and depth of the role of the partner post-cochlear implantation. Participants rated the *Partner Involvement* concept as highly important, recommending that future CI recipients should be made aware of partner responsibilities during pre-operative counselling.

CI recipients reported misconceptions concerning the extent of assistance provided by the CI, including instances where they were presumed to have normal hearing by their partners, which is in line with the findings of Mäki-Torkko et al. [29]. This relates to the significance of CI professionals' role in providing pre-operative counselling regarding realistic expectations concerning CI(s) for both CI recipients and their partners. Moreover, within the current study, the quadrant of the go-zone graph that represents the statements deemed to have a negative effect on couples' relationships and high importance was primarily from the *Partner Involvement* cluster. Understanding these aspects can help CI professionals customise their counselling, support, and intervention techniques to successfully address these problems, which may ultimately improve the couple's relationship and both parties' quality of life.

Völter et al. [28] evaluated third-party disability in CI recipients' close partners and established that although cochlear implantation has a positive effect on reducing the overall burden of hearing

loss, certain significant others still experience post-operative challenges, especially in their intermediary role during phone calls. In the present study, partners indicated that their mediatory position during telephone conversations had a "neutral" or "no effect" on their relationship, but CI recipients indicated that it had a "negative" effect on their relationship. It can be hypothesised that this phenomenon might develop when activities like answering the phone are part of a partner's daily routine and are therefore not perceived as additional responsibilities, whereas CI recipients may feel inadequate or embarrassed that their partner has to assist them. Participants' experiences were also in accordance with findings from Chen et al. [9] in that the need for significant others to act as a social bridge or be constantly concerned about the CI recipient's social interactions has diminished, reducing stress for both parties. Previously, the partner would step in for the CI recipient when it was apparent that communication was challenging. After cochlear implantation, they recognise the recipient's capability to communicate independently.

The *Communication* cluster revealed how some couples have more frequent conversations and share more with each other, whereas others still get frustrated due to poor communication, even after implantation. This finding also points to the variability and complexity of cochlear implantation outcomes. A decrease in casual conversations and the inability to communicate spontaneously could cause the couple to grow distant from one another [32]. Therefore, CI professionals should assess partners' communication approaches [34] to understand the communication dynamics within the relationship and help tailor rehabilitation strategies accordingly. Statements also related to inclusion when communicating with others, for example, how their children now engage the CI recipient in discussions at home, broadening the interactions beyond just them and the partner. This is an important factor highlighted by CI recipients as Bennett et al. [72] found that individuals with hearing loss are often excluded from conversations and interactions, which can lead to emotional distress. This underscores the significance of CI professionals recognising communication requirements for the CI recipient within their daily circumstances [64].

Interaction and communication are regarded as integral components of life [29], a sentiment underscored by participants in this study. Most participants described experiencing a favourable upsurge in communication with their partners after receiving the CI, underscoring the importance of hearing significant others and conversing in various settings such as driving or low-light environments. The primary beneficial subdomain of cochlear implantation identified by Kennedy et al. [7] was related to communication and conversation. This finding is supported by the current study, wherein almost half of the statements in the quadrant of the go-zone graph deemed to have a positive effect on couples' relationships and high importance originated from the *Communication* cluster. Participants noted that partners did not need to repeat themselves as frequently following implantation, which resulted in a noticeable reduction in frustration, correlating with evidence from hearing aid users and their partners [31].

Statements within the cluster *Emotional Adjustment* confirmed the varied impacts of cochlear implantation on couples' emotional well-being. Regarding positive effects, some participants described, for example, that the partner became more sensitive to the CI recipient's needs and how the couple can now share the experience of hearing sounds together. Conversely, other participants described mixed feelings, for example, how the partner must come to terms with the fact that the CI recipient may not be willing to engage in all their desired activities due to the ongoing challenges in communication. The consequent reduction in personal conversations can limit physical and emotional closeness [32]. Ask et al. [73] suggest that forthcoming studies should investigate elements contributing to mental health challenges resulting from hearing loss in families. The present study's findings address some of the mental health difficulties presented by hearing loss within the partner relationship context.

Furthermore, questionnaire responses from CI recipients illustrate that the sense of empowerment provided by a CI can result in a redefined equilibrium in personal relationships that positively influences both the CI recipient and those around them, transitioning from a position of needing assistance to becoming an autonomous individual [29]. Evidence from the current study indicated that some participants viewed this newfound independence positively in their relationship, and others still experienced ambivalence. Some CI recipients have an "internal struggle" with finding the equilibrium between self-sufficiency and when they require assistance from their partner. Similarly, some partners noted that their role in assisting the CI recipient was significant before cochlear implantation. However, after the implantation, partners felt that the CI recipient relied on them less extensively. Further investigation is required into the psychosocial and emotional effects of CI challenges and the methods CI professionals could use to mitigate these effects. Timmer et al. [42] established a comprehensive five-step strategy for audiological rehabilitation to effectively address the hearing needs of adults with hearing loss and their families while considering their social and emotional well-being.

Partners in the current study described a reduced sense of pressure in terms of facilitating communication due to their partner receiving a CI. They described a sense of relief in redistributing certain roles and responsibilities for which partners were once solely accountable. Both individuals in the relationship reported an augmented sense of independence, and partners exhibited reduced concerns about the CI recipient post-implantation. Partners found a sense of peace in knowing that CI recipients could manage independently, in line with findings from Mäki-Torrko et al. [29]. The emotional support provided to the CI recipient by the partner was also crucially positive, concurring with Glade [2]. Overall, participants in this study underwent a notable positive psycho-emotional change due to cochlear implantation.

Seminal work by Hétu et al. [74] described how the intimate relationship is significantly affected by hearing loss due to its interactive nature. Similarly, in a study by Govender et al. [32], spouses reported a significant challenge in intimacy within the relationship and a tendency to withdraw from their spouses with hearing loss. In the current study, the cluster *Relationship Intimacy* described how cochlear implantation has strengthened a couple's bond and improved their relationship. These findings highlight how cochlear implantation may address issues raised by Govender et al. [32] and Hétu et al. [74]. Participants in the current study further described how the CI recipient has changed for the better in the context of their relationship, where they have an increased ability to attend to more emotions and have become more confident after cochlear implantation. These findings concur with Levinger and Ronen [75], indicating that stronger self-esteem was associated with an increased capacity for intimacy within spousal relationships.

Participants also indicated an enhancement in relationship quality and a reduced overall sense of burden. Similar to Kennedy et al. [7], there was a frequent acceptance of the CI(s), often expressed with humour when reflecting on their pre-implantation circumstances. Lehane et al. [76] also found that spouses accepting the permanency of hearing loss can be advantageous, leading to increased support and reduced emotional upheaval within the

relationship. The dominant portion of all statements is situated in the upper right quadrant of the go zone graph, representing the most positive and important, and most statements pertain to the *Relationship Intimacy* cluster. This suggests that prioritising relationship aspects could be a strategic starting point for ensuring PFCC during the cochlear implantation intervention process.

Clinical implications

This study underscores that effective audiological treatment for severe and profound hearing loss extends beyond CIs alone [34]. The findings hold direct relevance for clinical practice by offering crucial insights into experiences and expectations for future CI recipients and their partners. These insights can also be integrated into training programs for hearing healthcare professionals. While significant others exhibit interest in auditory rehabilitation, their involvement in audiological appointments remains limited [77]. Cochlear implantation alleviates partner burden [28], highlighting the need for their comprehensive inclusion in the rehabilitation process as endorsed by Timmer et al.'s [42] clinical recommendations. Partner understanding and coping strategies significantly impact aural rehabilitation effectiveness and relationship harmony [32]. Audiologists are pivotal in facilitating partner engagement [78] and should offer tailored counselling, training, and psychological support. This study's identification of relationship changes can guide the creation of clinical training resources for couples and guidelines to incorporate these aspects in cochlear implantation pre-operative and post-operative counselling for better CI recipient and partner outcomes. Furthermore, clinicians can employ the conceptual framework to steer discussions on CI pre-implantation expectations, identify the need for tailored support throughout the rehabilitation process, offer personalised counselling on relationship changes post-CI, and develop training resources for enhanced patient care and relationship harmony.

The recent Cochlear Implant Task Force's *International Living Guidelines* acknowledge the broader implications of CIs, including benefits for families of CI users [79]. However, specific guidance for clinicians to support these needs is lacking. Given the importance of well-being, future guideline revisions should incorporate the audiologist's role in supporting CI recipients and partners. This study's findings could also be shared on the *Cochlear Implant International Community of Action* (CIICA) digital platform. These study results provide a framework for future research addressing cochlear implantation-related challenges.

Strengths, limitations and future research

The first strength of the current study is that it aligns with the principles of PFCC models as it included the perceptions regarding cochlear implantation of not only CI recipients but their partners as well. Moreover, considering the inherent nature of concept mapping, where participants engage in data collection, analysis and interpretation, the outcomes of this study hold face validity and significant applicability to clinical practice. Furthermore, concept mapping promotes collaboration among researchers and participants, fostering a shared understanding of the impact of cochlear implantation on the partner relationship.

The study aimed to recruit a diverse sample in terms of ethnicity, sex, and duration of CI use to ensure that study outcomes are representative of the broader community. However, participant recruitment faced challenges, leading to a limited number of individuals willing to participate despite inviting a diverse range of individuals. Due to the small sample size and recruitment from only two CI centres in one country, inferences regarding the concepts identified herein may not be generalisable to the broader community; a large-scale survey would be required to investigate the generalisability of the results herein. Incorporating consumer and community involvement into future research efforts could strengthen the design and delivery of studies investigating the impact of adult cochlear implantation on relationships [80]. Additionally, participants might have overlooked mentioning everyday issues that the CI recipient has already adapted to or obvious problems that have become a routine part of their daily life management [7]. Moreover, significant others might echo the perspectives of the CI recipient rather than express their own [81]. In future studies, exploring the relationships between CI recipients and their partners before and after receiving a CI would be beneficial, enabling more effective comparisons. Nevertheless, the results offer valuable insights and a comprehensive framework for enhancing the cochlear implantation journey through support and education for couples as well as CI professionals.

The development of a conceptual framework deepens our comprehension of the impact of cochlear implantation on partner relationships and serves to guide both clinical practice and future research directions. The framework derived herein elucidates topics of importance to CI recipients and their partners. Moreover, conceptual frameworks such as this have the potential to mitigate the impact of researchers' cultural, social, or perceptual biases [82], thereby expanding our conceptualisation of the potential challenges, risks, and rewards facing adult CI recipients and their partners. Operationalising the conceptual models may include implementing targeted interventions, refining clinical protocols, and fostering interdisciplinary collaborations to enhance audiological rehabilitation outcomes and address the multifaceted needs of CI recipients and their partners. Future research could leverage the conceptual framework to provide a systematic approach to developing outcome measures [83,84] that accurately capture the multifaceted impact of cochlear implantation on the partner relationship. Future research could also include the development of a conceptual framework for older adults (>65 years) to ensure a diverse understanding of the impact of adult cochlear implantation on the partner relationship. Given the sample size, we did not examine whether participant demographic or audiological data (i.e., gender, age, CI fitting type) were associated with brainstorming, grouping, or rating outputs. Exploring these factors and whether a partner's hearing difficulties have an influence on the CI recipient-partner relationship are options for future research.

Conclusion

The study developed a conceptual framework describing five critical concepts in partner relationships that should guide cochlear implantation service provision. These concepts shed light on various dimensions of the post-cochlear implantation partner relationship. Notably, the *'Relationship Intimacy'* cluster was deemed the most important and positive, suggesting its significance in the context of future CI interventions. The findings highlight the positive changes in social engagement and interaction dynamics the CI(s) brought about. This study also underscores the instrumental role partners play in supporting CI recipients in managing communication and contributing to emotional adjustment. Improved communication, increased relationship quality, and diminished burdens emerged as recurrent themes consistent with related research. The emphasis on relationship intimacy and the necessity to address social interactions, partner involvement,

communication strategies, and emotional dynamics have important implications for clinical practice, particularly in terms of personalised hearing rehabilitation plans encompassing the needs of both CI recipients and their partners.

Acknowledgements

We are profoundly thankful to the study participants and extend our sincere appreciation to the Pretoria Cochlear Implant Unit and the Johannesburg Cochlear Implant Centre for their vital collaboration in participant recruitment.

Data availability

The data examined in this study will be accessible upon reasonable request from the corresponding author.

Disclosure statement

The authors do not have any conflicts of interest to disclose.

Funding

The author(s) reported there is no funding associated with the work featured in this article.

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