Adherence and satisfaction in Argus II prosthesis users: a self determination theory model

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ABSTRACT

**Background:** Self-determination theory (SDT) of human motivation was used to examine associations between different forms of motivation in Argus II retinal prosthesis users and their engagement and satisfaction with the Argus device.

**Materials and Methods:** Nine subjects were administered: 1) a Situational Motivation Scale (SIMS) questionnaire to measure intrinsic motivation, identified regulation, external regulation, and amotivation, and 2) the Argus questionnaire (AQ) which was organized into 5 categories to measure Decision to get an Argus implant, Self-perception as an Argus user, Utility of Argus, Perceived competence, and Family support. Spearman correlations ($r_s$) were used to find associations between measures from SIMS and AQ.

**Results:** Nine subjects completed both questionnaires. Statistically significant associations were observed between identified regulation and AQ items from categories: Decision to get Argus, Self-perception, Utility of Argus, and Perceived competence; and between intrinsic motivation and AQ items from Self-perception and Utility. External regulation was negatively associated with Family support, and amotivation was associated with one item from Self-perception. Engagement with the device and satisfaction were associated to both identified regulation and intrinsic motivation. There was no significant relationship between external regulation and adherence to the device.

**Conclusions:** The SDT model can be used to investigate the types of motivation that influence uptake and engagement of the Argus device. Clinicians can use this knowledge to improve outcomes by supporting confidence in users and by encouraging them to maintain internalization and continued commitment to adherence.

Introduction

The Argus II retinal prosthesis system (Second Sight Medical Products, Inc., Sylmar, CA) is a surgically implanted medical device that is designed to restore partial vision in patients with retinitis pigmentosa who have bare to no light perception. The Argus II consists of a miniature camera mounted on a pair of eyeglasses, an external video processing unit (VPU) worn by the patient, and an internal epiretinal array consisting of 60 electrodes implanted on the retinal surface. Visual information from the camera is processed by the VPU to form electrical signals that are transmitted wirelessly to the array and induce electrical stimulation of the electrodes, resulting in the stimulation of the preserved inner retinal neurons and subsequently eliciting percepts or phosphenes in the brain (1,2). The Argus II does not restore normal vision, color vision, or provide true representations of features. The patient’s field of view with the Argus II device, is limited to 11° x 19°, or diagonally by 21°. Visual perceptions enable rudimentary identification of objects. The post-operative phase consists of several weeks of low vision rehabilitation when patients learn to use the VPU controls, are taught to make frequent head movements to scan across the visual field, direct the camera towards objects in the visual scene, and to interpret the visual percepts. Making head movements additionally serves to refresh the captured image to prevent stationary objects in the field of view from fading. Studies using the Functional Low-Vision Observer Rated Assessment (FLORA) instrument to evaluate functional vision have shown that Argus recipients were able to perform certain tasks when the device was “ON” that they were unable to complete when the device was “OFF” (3).

Since the Argus II is a relatively new technology, little to no information is available regarding the influence of behavioral factors on engagement and motivation to use the device. A literature review showed that the closest analogy to usage of the Argus II device is hearing aid adoption, where motivation has been shown to have an impact on the success of hearing rehabilitation (4-6). Observations of our patients’ experiences with the Argus II device have revealed to us that while some Argus users can become frustrated and dissatisfied, and consequently use the device infrequently or not at all, other users are highly satisfied with the visual experience and use it daily. For devices used independently outside the clinic, such as the Argus II, there are likely to be motivational factors that influence the users’ levels of adherence and engagement with the treatment (7).

The success of most health interventions is highly dependent on the patient’s adherence to the treatment, which in effect mediates health outcomes. It is important to note that despite prolific technological advancements within medicine...
over the years, it is really human behavior that determines how health decisions are made and what outcomes are ultimately manifested through those enacted behaviors (4-6).

The present study utilized the perspective of the self-determination theory (SDT) model of behavioral factors for motivation and adherence (or adoption) to the Argus II (8). According to SDT, changes in health outcomes, such as treatment adherence and engagement, are dependent on the patient’s experience and motivation, in addition to the patient’s experience of self-determination.

SDT proposes that it is necessary for an individual to develop a sense of autonomy, competence, and relatedness in order to be able to maintain behaviors that are conducive to health (9-11). When a person feels autonomous, they value the behavior and its importance. Competence is when the person gains a sense of confidence and ability to enact the behavior (or be engaged in treatment) using the tools and skills provided by the health provider. Relatedness is defined as the health provider-patient relationship that is conducive to the change wherein the patient feels respected and cared for. Research involving SDT has shown that health outcomes are more successful when the patient’s psychological needs of autonomy, competence, and relatedness are met (11). SDT argues that the processes of internalization and integration, through which an individual develops self-regulation and behaviors conducive to health and well-being, depends on having a sense of competence and autonomy.

Furthermore, individuals will more likely participate and maintain the desired health behaviors if they have internalized the value of the activity and therefore experience self-determination (10,12). SDT distinguishes among different types of motivation (intrinsic, extrinsic and amotivation) based on the individual’s goals or reasons that result in an action. The concepts of internalization and regulation styles are described as a continuum of how one’s motivation or behavior can range from intrinsic motivation, to extrinsic motivation to amotivation (Figure 1) (8,13). Intrinsic motivation is where behaviors are engaged for their own pleasure and the satisfaction derived from performing them (14-16). Extrinsic motivation is further subdivided into a variety of regulation styles that can be ordered along the self-determination continuum (13). Ranging from lower to higher levels of self-determination are external regulation and identified regulation (15,17). External regulation occurs when an individual experiences an obligation to behave in a specific way, and to satisfy an external coercion or to receive a reward. Identified regulation is considered to be a more autonomous form of extrinsic motivation since the behavior is valued and perceived by the person as chosen by oneself (10,14). The motivation is still considered as extrinsic because the activity is done for its value with respect to the outcome rather than for itself. Amotivation is similar to learned helplessness, where the individual experiences feelings of uncontrollability and incompetence (13). These four types of motivation differ in their levels of self-determination and could be associated with altered psychological functioning (13,17).

The different types of motivation are based on the different reasons or goals that result in an action. For example, situational motivation is a type of motivation that a person feels when they are currently involved in a particular activity, and thus provides an understanding of a person’s current level of self-regulation (17,18). It is measured at a given point in time and is related to psychological outcomes like positive outcomes and vitality (17-19). Situational motivation sub-classifies extrinsic motivation into two regulation styles, which are identified regulation and external regulation (17).

The influence of motivation factors in health outcomes and behavior has been studied in interventions including hearing aid adoption (6,20), medication adherence in asthma (21), health behaviors (22), exercise and sports for health promotion (23,24), and in psychiatry (25,26).

The aim of this study is to understand the motivational factors that play a role in the uptake and engagement of the Argus II device. We used SDT to examine associations among different forms of motivation with the patient’s adherence to and

Figure 1. Self-determination theory diagram- situational motivation classifies motivation as intrinsic motivation, extrinsic motivation (which is further sub-classified into identified regulation and external regulation) and amotivation, which are based on a continuum from high to low levels of self-determination.
satisfaction with the Argus II retinal prosthesis. This was achieved by administering: a) a situational motivation scale questionnaire, which is a measure of situational motivation based on the SDT constructs of intrinsic motivation, external regulation, identified regulation and amotivation (Figure 1), and b) an Argus questionnaire developed by the authors as a self-reported measure of satisfaction with and adherence to the Argus prosthesis.

Materials and methods
The study protocol and the informed consent process were reviewed and approved by the Institutional Review Board of the University of Michigan Medical School.

Subjects
Patients who underwent the Argus II implant surgery at the Retina clinic of the Kellogg Eye Center, University of Michigan were recruited for the study. All subjects had advanced retinitis pigmentosa and bare light perception vision in both eyes. Demographic data and date of surgery were collected from medical records.

Questionnaires
Subjects were asked to complete two questionnaires and answer 5 open-ended questions.

SIMS questionnaire
A validated 16-item Situational Motivation Scale questionnaire (SIMS, Supplementary Table 1) was the first survey utilized (adapted from Guay et al. [17], and with permission from the author) to assess different types of motivation our patients may be experiencing while using the Argus device. Minor changes in the wording were made to repurpose the questions for Argus users. For example, the word “activity” was replaced by “use of Argus” and the 7-level Likert scale was changed to a 5-level scale. Four categories were explored with the SIMS questionnaire: Intrinsic Motivation, Identified Regulation, External Regulation and Amotivation.

Argus questionnaire
A second survey, the Argus questionnaire (AQ, Supplementary Table 2), was developed based on qualitative analysis of our clinical observations of Argus patients’ experiences with the Argus device, which resulted in the identification of five major areas: 1) Decision to get Argus; 2) Self-perception as an Argus user; 3) Utility of the Argus; 4) Perceived Competence; and 5) Family Support. As a preliminary approach, we constructed a 20 item, 5-level Likert scale Argus Questionnaire from areas 1, 2, 3, 4 and 5. The AQ was not validated. For both the SIMS and AQ, scores ranged from 1 (“strongly disagree”) to 5 (“strongly agree”). Three items in the AQ were phrased in the negative direction to avoid acquiescence bias and to maintain subjects’ attentiveness.

Open-ended questions
Subjects were asked: (i) if they were still using the Argus, (ii) if so, then for how many hours a week did they use the device, (iii) if they had a previous history of orientation and mobility training (including cane training or guide dog training) prior to Argus implantation, (iv) if they had completed orientation and mobility training after receiving the Argus implant, and (v) any additional factors that encouraged or discouraged them to use the Argus.

Survey administration
The inclusion criterion was that subjects had to have been using the Argus for at least 90 days after device activation. Following telephonic informed consent, the surveys were administered over the phone by a study team member and answers were recorded on the respective survey forms.

Statistical analysis
Statistical analyses were performed with IBM SPSS version 24.0, Armonk, NY, IBM Corporation. Scores of the negatively phrased items were reversed before analyses were conducted. In both surveys, the overall median score of all items within each category was obtained (6). Spearman rank correlations ($r_s$) were used to find relationships between measures from the SIMS questionnaire (intrinsic motivation, identified regulation, external regulation and amotivation) and items from the variables of our constructed Argus questionnaire. Spearman correlations were also obtained with age, gender, and duration of use of Argus.

Results
Subjects were 9 Argus users, which included 5 males, (age range 48 to 75 years) and 4 females, (age range 66 to 81 years). All nine subjects completed both questionnaires. The duration from device programming to survey completion ranged from 91 days to 694 days (Table 1). The total time taken by the subjects to complete the two surveys was approximately 15 minutes.

SIMS questionnaire
For the SIMS questionnaire, a higher median score between 4–5 indicates a higher level of the particular type of motivation (6). Most subjects demonstrated value recognition of using the Argus suggesting influence of identified regulation (Table 2), which had the highest overall median score of 4.75. Overall median scores for other categories were 3.75 for intrinsic motivation, and 2.00 for both external regulation and amotivation.

Combined response frequencies, reflecting Agree and Strongly Agree (scores ≥ 4), or Disagree and Strongly Disagree (scores ≤ 2) showed that for intrinsic motivation,

| Table 1. Patient characteristics. |
|----------------------------------|
| **ID** | Gender | Age (years) | Duration of use (days) |
|-------|--------|-------------|------------------------|
| P1    | M      | 57          | 694                    |
| P2    | M      | 75          | 299                    |
| P3    | M      | 66          | 91                     |
| P4    | M      | 67          | 132                    |
| P5    | F      | 77          | 645                    |
| P6    | F      | 67          | 679                    |
| P7    | M      | 48          | 319                    |
| P8    | F      | 81          | 644                    |
| P9    | F      | 66          | 161                    |
most subjects (7/9) agreed that they thought the Argus was interesting and that they felt good when using it. Only 3/9 subjects agreed that the Argus was pleasant and fun to use (items 5 and 9). For identified regulation, 9/9 subjects agreed that they were involved in the activity of using the Argus because they thought it was their personal decision and felt it was important and beneficial for them. Likewise, for external regulation, 9/9 subjects strongly disagreed they were being compelled or rewarded by an external source to use the device. Amotivation was very low in these patients with 1/9 to 2/9 subjects showing that very few were indifferent to using the Argus.

### Argus questionnaire

Similar to the SIMS Questionnaire, a higher median score between 4–5 indicates a higher level of the particular category measured (6). Of the five categories on the AQ, the highest overall median score was 4.25 for decision to get Argus, and 5.00 for family support (Table 3). Overall median scores for the other categories were 3.17 for self-perception as an Argus User, 3.00 for utility of Argus, and 2.80 for perceived competence. Response frequencies, reflecting Agree and Strongly Agree (scores ≥ 4), or Disagree and Strongly Disagree (scores ≤ 2) are stated below for items within each category.

### Decision to get Argus

All nine subjects strongly agreed with item 1, “I made the right decision in getting the Argus.” Additionally, most subjects agreed with item 10 “Expectations of the type of vision I would have with Argus were clearly explained to me” (8/9 subjects). However, item 5, “I am satisfied with what I see with the Argus,” showed scores that were spread across the scale. All subjects (9/9) disagreed with item 15, “I regret the decision to get the Argus.”

### Self-perception as an Argus user

All subjects (9/9) strongly agreed (score = 5) with item 11, “I feel privileged to be one of the few patients in the United States to receive this new technology.” Most subjects disagreed with item 19, “I feel uncomfortable wearing the Argus in public” (7/9 subjects), and with item 9, “I feel that I have to wear my Argus glasses to please my family and friends” (7/9 subjects). For item 2, 7/9 subjects disagreed with the statement, “No one to talk to about my experience with Argus,” for item 6, 6/9 subjects agreed with the statement, “Others expect a lot from me when using the Argus.” Scores were spread across the scale for item 16, “I feel frustrated because no one understands my experience with the Argus.”

### Utility of Argus

Three items examined in this variable were related to the usefulness of the Argus. The scores for item 7, “I bump less often into objects around me,” frequencies varied from 3/9 subjects disagreeing (score ≤ 2) to 5/9 subjects agreeing (score ≥ 4), with the statement, while one subject was neutral (score = 3). Item 12, “I do not find the Argus useful for my daily activities,” had scores that were spread across the scale (score ≥ 2 for 5/9 subjects, score = 3 for 2/9 subjects, and score = 5 for 2/9 subjects). Item 17, “The Argus helps me navigate confidently,” had a split response (scores ≤ 3 for 5/9 subjects and scores ≥ 4 for 4/9 subjects).

### Perceived competence

There were five items in this category that were related to the ability to use the hardware and software settings. For item 8, 7/9 subjects disagreed with the statement, “It is difficult to change the battery and settings on the VPU,” indicating that the subjects felt competent doing this task. Lastly, item 13 “It is easy to understand how to use the settings on the VPU,” also had a majority of the subjects agreeing (7/9, score ≥ 4).

For item 4, 6/9 subjects were either neutral or disagreed that they were satisfied with the straps for the VPU. For item 18, 5/9 subjects agreed or were neutral, while 4/9 subjects disagreed with the statement, “I feel frustrated because changing the VPU settings does not improve what I see.” Scores were spread out for item 20, “Wearing the Argus fatigues me” for which 5/9 subjects agreed (score ≥ 4), 2/9 subjects were neutral (score = 3), and 2/9 subjects disagreed (score ≤ 2).

### Family support

There was one item, number 14, in this category for which a majority of subjects (8/9) agreed that family/peer support is important when practicing using the Argus. However, one subject was neutral to this statement.

### Associations between the AQ and SIMS

Table 4 shows Spearman’s rank-order correlations for AQ survey items (Supplementary Table 2) that were significantly associated with a type of motivation. As described below, multiple items showed significant associations with intrinsic motivation and identified regulation, whereas there was a significant association with just one item each in external regulation and amotivation.

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**Table 2. SIMS questionnaire statistics.**

| Median | Intrinsic Motivation | Identified Regulation | External Regulation | Amotivation |
|--------|----------------------|-----------------------|---------------------|-------------|
| Percentiles | 3.75 | 4.75 | 2.00 | 2.00 |
| 25th percentile | 2.50 | 4.00 | 1.00 | 1.00 |
| 75th percentile | 4.00 | 4.75 | 2.00 | 2.13 |
| Interquartile Ranges (IQR) | 1.50 | 0.75 | 1.00 | 1.13 |

**Table 3. Argus questionnaire statistics.**

| Decision to get Argus | Self-perception as an Argus User | Utility of Argus | Perceived Competence | Family Support |
|-----------------------|----------------------------------|-----------------|---------------------|---------------|
| Median | 4.25 | 3.17 | 3.00 | 2.80 | 5.00 |
| Percentiles | 25th percentile | 3.75 | 3.00 | 2.50 | 2.60 | 4.00 |
| 75th percentile | 4.75 | 3.75 | 3.67 | 3.40 | 5.00 |
| Interquartile Ranges (IQR) | 1.00 | 0.75 | 1.17 | 0.80 | 1.00 |
Table 4. Spearman’s correlations between Argus and SIMS questionnaires.

| Category/Question Number | Intrinsic motivation | Identified regulation | External regulation | Amotivation |
|--------------------------|----------------------|-----------------------|---------------------|-------------|
| Decision to Get Argus    |                      |                       |                     |             |
| 1. Made the right decision in getting the Argus. | 0.421 | *0.706 | 0.165 | −0.496 |
| 10. Expectations were clearly explained before receiving the Argus. | 0.492 | *0.771 | −0.500 | *−0.685 |
| 15. I regret the decision of getting the Argus. | 0.421 | *−0.706 | 0.165 | −0.496 |
| Self-Perception          |                      |                       |                     |             |
| 2. No one to talk to about my experiences with the Argus. | **−0.831** | −0.144 | 0.259 | 0.478 |
| 9. I feel I have to wear Argus glasses to please family and friends. | *−0.698 | *−0.790 | 0.412 | *0.777 |
| Utility of Argus         |                      |                       |                     |             |
| 12. I do not find the Argus useful for my daily activities. | *−0.786 | −0.622 | 0.114 | 0.617 |
| 17. The Argus helps me navigate confidently. | 0.144 | *0.698 | −0.090 | −0.382 |
| Perceived Competence     |                      |                       |                     |             |
| 8. It is difficult to change settings and battery on the VPU. | −0.571 | *−0.738 | 0.521 | 0.621 |
| Family Support           |                      |                       |                     |             |
| 14. Family and peer support is important to me. | 0.114 | 0.450 | *−0.734 | −0.099 |

* Statistically significant at p < 0.05.
** Statistically significant at p < 0.01.

**Decision to get Argus**

 Identified regulation was associated with three items under the category, “Decision to get the Argus prosthesis,” indicating that users acknowledged the importance of the device. For example, there was a significant positive association between identified regulation and item 1, “I made the right decision in getting the Argus,” (r_{S} = 0.71, p = 0.034). Item 10, “Expectations of the type of vision I would have with Argus were clearly explained to me,” had a positive association with identified regulation (r_{S} = 0.77, p = 0.015) and a negative association with amotivation (r_{S} = −0.69, p = 0.042). Item 15, “I regret the decision to get the Argus” had a negative association with identified regulation (r_{S} = −0.71, p = 0.035).

**Self-perception as an Argus user**

 In this category, item 2, “no one to talk to about my experiences with the Argus” had a significant negative association with intrinsic motivation (r_{S} = −0.831, p = 0.006). Additionally, item 9, “have to wear glasses to please others,” had negative associations with both intrinsic motivation (r_{S} = −0.70, p = 0.04) and with identified regulation (r_{S} = −0.79, 0.01), and a positive association with amotivation (r_{S} = 0.78, p = 0.014).

**Utility of Argus**

 Item 12, “I do not find the Argus useful for my daily activities” was negatively associated with intrinsic motivation (r_{S} = −0.79, p = 0.012). Item 17 “Argus helps me to navigate confidently” had a positive association with identified regulation (r_{S} = 0.70, p = 0.04) demonstrating that users were focused on the positive outcomes of using the device.

**Perceived competence**

 Item 8, “It is difficult to change the settings and battery on the VPU,” had a negative association with identified regulation (r_{S} = −0.74, p = 0.02).

**Family support**

 This single item category from the AQ, item 14, “My family/peer support is important to me when I am practicing using the Argus,” was negatively associated with external regulation (r_{S} = −0.73, p = 0.024).

There were no associations between any of the survey items and duration of use or with gender. There was a strong positive association between age and AQ item 12, “I do not find the Argus useful for my daily activities” (r_{S} = 0.91, p = 0.001). Before the surveys took place, subjects P1, P5, P6, and P8 (3 females) had been using the system for about 22 months, while 2 males (P2 and P7) used the Argus for about 10 months, and the remaining 3 respondents (2 males, P3, P4 and 1 female P9) for about 3 to 5 months (Table 1). P2 (75 y/o male, 10 months of use) and P8 (81 y/o female, 22 months of use) strongly agreed with AQ item 12, “I do not find the Argus useful for my daily activities,” whereas P1 (57 y/o male, 22 months of use), P3 (66 y/o male, 3 months of use) and P7 (48 y/o male, 10 months of use) strongly disagreed with the statement indicating that they found the Argus useful for their daily activities.

**Discussion**

 This study used the self-determination theory as a theoretical framework to examine whether the motivations in Argus users were associated with decision to get the Argus II device, self-perception as an Argus user, utility of the Argus, perceived competence for using the device, and family support. By identifying associations between specific domains of motivation and each item in the Argus questionnaire, we demonstrated that Argus users are influenced by both identified regulation and intrinsic motivation in this cohort. Additionally, external regulation and amotivation had no significant influence in user compliance and adherence to the Argus protheses.

**SIMS questionnaire**

Uptake and engagement with the Argus were associated with both intrinsic motivation and identified regulation. Intrinsically motivated users found the device to be interesting and felt good when using it, which demonstrates the cognitive aspect. However, the emotional aspect was not present because the users did not think that using the Argus was pleasant or fun. All four items in the identified regulation category had high median scores ranging from 4 to 5, wherein all users affirmed that engaging with the device was their personal decision. They endorsed the value of using the
device and that it was for their own good. The higher median scores for identified regulation and intrinsic motivation found with the responses in the SIMS survey were supported by the lower median scores of external regulation and amotivation. Subjects did not feel they were being compelled by external factors to use the device or that they had no choice but to use it.

Subjects also did not agree with statements that the Argus was not worth it, or that it does not provide any benefit to them by pursuing to use it regularly with two exceptions. Subject P2 (75 y/o male, duration of use 299 days) who scored high on the items under the amotivation category did not think there were any good reasons for using the device. Although, this subject stated he used the device frequently, he did not think it was worth it nor felt good when using it. User P2 had physical limitations that prevented his ability to make extensive head movements to scan the visual scene. This could be a reason for his lack of competence and interest. Another user, P5 (77 y/o female, duration of use 645 days), although scoring high on intrinsic motivation and identified regulation, reported that she used the Argus because she was supposed to, which was consistent with external regulation.

The response from most participants on disagreeing that the Argus was not worth it and did not provide benefit, could have been influenced by inadvertent external regulation created by the clinical team (10). Subjects could have felt a reluctance to express disappointment with the device or felt obliged to please the clinical team (10). While we do not have any direct evidence from this study, we have observed during clinical visits that two subjects (P5, 77 y/o female and P8, 81 y/o female) consistently asserted to some clinical team members that they found the Argus to be useful and provided examples of the objects they had perceived. However, they also reported their disappointment with the device in discussions with other clinical team members. Since we did not include any questions in the AQ to determine tester’s influence, and since our observations are based on a small sample size, we cannot conclude that the subjects felt an obligation to please the clinical team.

**Associations between the AQ and SIMS**

Argus users strongly believed that they made the right decision in getting the device. Users with high identified regulation were more likely to identify the usefulness of the device, thus engaging in the behavior of using the device and finding it beneficial. Though all users strongly felt that the expectations of the type of vision that the Argus device would provide were clearly explained before the intervention, these users were still not satisfied with what they perceived with the device. As may be expected, these statements were not associated with any of the motivations.

Those who were intrinsically motivated had a higher perception of themselves as an Argus user. This suggests that those who were interested in using the Argus and felt good when using, were more likely to view themselves as an Argus user in a positive way. They also were not dependent on others to talk to about their Argus experience. Since intrinsically motivated individuals rely on themselves to engage in the behavior for the satisfaction derived from the activity, it is likely that these users do not feel the need to talk to others to seek appreciation or praise to make the behavior a more meaningful experience. However, the negative association between intrinsic motivation and having someone to talk to about the Argus experience (AQ item 2) was unexpected given the assumption that a highly intrinsically motivated individual would want to discuss their experience. Most users responded that they did not have to wear the Argus glasses to please others. This item was negatively associated with intrinsic motivation and with identified regulation suggesting that they did not feel compelled by others to wear the glasses. However, external regulation was not shown to be associated significantly with these responses. All users felt privileged to be one of the few patients in the country to have received the new technology. However, this item was not associated with any of the SDT variables.

The aim of the Utility of Argus category was to assess whether study subjects perceived that the Argus enabled them to navigate more confidently and bump less often into obstacles, and it appeared that these activities/tasks had different levels of importance to the users. Users with identified regulation reported that the device helped them navigate confidently. Such individuals were more likely to be satisfied with the device and more likely to identify its utility. With respect to subjects who did not find that the Argus helped them navigate confidently, it is conceivable that they were able to effectively navigate in their homes prior to the intervention; their expectations for the device thus may not have been directed to improving navigation. Their goals may have been for social interactions rather than for navigation. For example, when talking to someone, being able to perceive where the person is in relation to their own physical position.

The positive association between age and not finding the Argus useful for daily activities (AQ item 12) warrants further evaluation since the term “daily activities” is broad and may have a different connotation for different respondents. While some subjects found the Argus useful for daily activities, others did not. The study needs replication with a larger sample size to explore the types of activities that could be associated with gender and age.

Family support was important to all users during the process of learning and engaging in the activity. The negative association between family support and external regulation suggests that while it was important for these individuals to receive positive support from family and peers when practicing using the Argus, doing so was a personal decision and not a product of coercion. This item was not associated with intrinsic motivation or with identified regulation.

Our study revealed that the strong identified regulation, and to some extent the strong intrinsic motivation, show the individualistic aspect of these Argus receivers. It was their personal decision to opt for the device and believed it would improve their quality of life. It is possible that our observation of high identified regulation and intrinsic motivation and low external regulation in this group could be because those individuals who were already highly motivated were the ones who chose to go through with this treatment. Another reason could be the influence of external factors such as a positive clinician-patient
relationship including friendliness, encouragement, support, emphasis on the benefits and importance of using the device regularly to enable them to integrate with their personal goals of achieving improved visual outcome (27,28).

Our results are comparable to other studies that have utilized the SDT framework to examine the influence of different motivations on health behavior. In hearing aid technology, autonomous motivation, also referred to as identified regulation (8), was shown to be positively associated with hearing aid adoption (11) and with hearing aid satisfaction (6). In a study on computer-based auditory training (20) engagement and adherence to the training were found to be influenced by intrinsic motivation, consistent with participants finding the activity to be interesting and enjoyable and with their desire to achieve higher scores. Adherence to the training was also influenced by extrinsic motivation which was shown to be consistent with an external factor like the users’ desire to help others with hearing loss. In a study utilizing the SIMS questionnaire (28) to investigate patient participatory behaviors in healthcare service delivery, patients’ commitment to compliance was significantly influenced by identified regulation and intrinsic motivation but not by external regulation (28). Patient participation in clinic consultations, however, was influenced more strongly by identified regulation than by intrinsic motivation.

The main limitations in our study are (1): The small sample size. Considering the rarity of retinitis pigmentosa and especially of those patients with end stage disease and profound blindness, there were only a small number of patients receiving Argus implants at any given clinical center. A multicenter study would have increased the number of participants (2). Despite the finding that identified regulation was found to be a strong SDT component in this small cohort, our study does not have the statistical power to assess which users scored high on each of the 4 types of motivations that were examined. However, our results do support a direction to the outcomes that were evaluated (3). The AQ is not a validated questionnaire, nevertheless it does have content validity for the application to subjects in this study (4). Another consideration is a source of potential bias due to the extent of clinician-patient interactions at this facility are different from other centers that were serving Argus users. All 9 users went through rehabilitation by the same clinician at this facility and thus the participatory behaviors in our subjects could conceivably be biased towards the extent of their commitment and compliance. Device programming as well as follow up modifications to the device settings and programming were performed by N. W.K. in 7 of 9 users. Although technical guidance and support were provided in some instances by Second Sight Medical Products, it is conceivable that: a) users could have been biased in the manner they utilized the device based on the way instructions were given, or b) they may have been influenced by the encouragement and support provided to improve adherence to the device. Therefore, clinicians at this facility could have created external regulation by emphasizing to patients that better visual outcomes may be achieved by active and regular use of the device.

It would be interesting and beneficial to conduct a long-term follow-up study using a larger number of subjects and longitudinal research design to examine how the Argus users’ perspectives and motivations change over time. Response to the open-ended questions revealed that although most users were satisfied with their decision to get the Argus, they felt that the device could provide more enhanced vision and were hopeful that technological upgrades and improvements would be available. Although Second Sight Medical Products discontinued production of the Argus II retinal prosthesis system in April 2020, other similar implantable visual prosthetic devices and systems may be developed in future. When designing and implementing these new devices, it will be important to consider motivational factors that enable their successful usage to tailor the devices appropriately and to support patients who may wish to utilize them.

In summary, our study shows that the SDT model can be used to gain an understanding of the types of motivation and the influence these motivations have on the internalization of and adherence to home-based visual restoration interventions such as the Argus II device. The subjects in this study valued the importance of using the device and affirmed that they were involved in the activity by their personal decision implying the influence of identified regulation. Subjects found that using the Argus was interesting and they felt good about using it indicating the effect of intrinsic motivation. However, these subjects asserted that they were not being compelled or enticed by rewards to use the device, demonstrating that they were not externally regulated. These findings provide insights to health care providers working with patients using visual prosthetic devices to improve compliance and provide support to enhance internalization and continued adherence.

Acknowledgments
The authors thank Leslie Nizioł for support with data analysis.

Disclosure statement
No potential conflict of interest was reported by the author(s).

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

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