Stimulation vestibulaire et de la vigilance chez les personnes atteintes de déshabilités intellectuelles profondes et multiples

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Mots-clés

Vigilance , personnes atteintes de déshabilités intellectuelles profondes et multiples, la stimulation vestibulaire , la stimulation lointaine

Résumé

Contexte : Les personnes avec déshabilités intellectuelles profondes et multiples (PIMD) éprouvent un grand nombre de difficultés lors d'activités. La stimulation vestibulaire a été décrite comme une condition préalable à d'autres types de stimulation, la présente étude met donc l'accent sur ce type de stimulation.

Méthode : Les observations vidéo ont été réalisées pour 21 participants au cours des interactions en tête-à-tête avec une personne de soutien direct (DSP) dans trois situations différentes: 1) la stimulation vestibulaire, 2) la stimulation visuelle/auditive, et 3) la stimulation visuelle/auditive vestibulaire suivant la stimulation de la vigilance en tant que variable dépendante. Chaque situation a été filmée une fois pour chaque participant.

Résultats : Les statistiques descriptives ont révélé plusieurs différences dans les réactions de vigilance entre les conditions étudiées. Ces différences ne sont pas statistiquement significatives. En outre, de grandes différences entre les sous-groupes en fonction du sexe, des groupes d'âge, de la déficience visuelle et de l'épilepsie ont été trouvées.

Conclusions : les DSP peuvent être conseillés pour adapter les situations de stimulation aux besoins et aux préférences individuelles avant de présenter la stimulation vestibulaire à des personnes avec PIMD.

Vestibular stimulation and alertness in individuals with profound intellectual and multiple disabilities

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Keywords

Alertness, individuals with profound intellectual and multiple disabilities, vestibular stimulation, distant stimulation

Abstract

Background: Individuals with profound intellectual and multiple disabilities (PIMD) experience a large number of difficulties when engaging in activities. Because vestibular stimulation has been described as a precondition for other types of stimulation, the present study focuses on this type of stimulation.

Method: Video observations were conducted for 21 participants during one-on-one interactions with a direct support person (DSP) in three different situations: 1) vestibular stimulation, 2) visual/auditory stimulation, and 3) visual/auditory stimulation following vestibular stimulation with alertness as the dependent variable. Each situation was videotaped once for each participant.

Results: The descriptive statistics revealed several differences in alertness reactions between the conditions. Still, these differences were not statistically significant. In addition, large differences between subgroups based on gender, age groups, visual impairment, and epilepsy have been found.

Conclusions: DSPs can be advised to adapt the stimulation situation to the individual needs and preferences before presenting vestibular stimulation to individuals with PIMD in clinical practice.

Introduction

Alertness in individuals with profound intellectual and multiple disabilities (PIMD) has been described as one of the most important preconditions for engaging with the environment and engaging in activities. Only when the individual is alert and focused on the environment can stimuli enter the consciousness of the individual with PIMD and can, thereby, become meaningful in the process of learning and development (Guess, Roberts, & Guy, 1999).

However, individuals with PIMD form a special target group because of the complexity of their disabilities. According to the definition of Nakken and Vlaskamp (2007), individuals with PIMD experience a significant limitation in motor and sensory abilities next to their profound intellectual disability. In addition, health problems, such as epilepsy, pulmonary infections, or sleep disorders, are common. While the combination and severity of these disabilities may vary for each individual, the common characteristic of all individuals with PIMD is their pervasive need for support in their daily lives (Nakken & Vlaskamp, 2007).

Although direct support persons (DSPs) and researchers agree about the importance of alertness in daily care and in support for individuals with PIMD (Munde, 2011), they also face a number of issues concerning the alertness of their clients. DSPs wonder how to determine the level of alertness, as alertness expressions are often subtle signals that can easily go unnoticed (Mudford, Hogg, & Roberts, 1997). Therefore, individual differences in alertness expressions aggravate the task for DSPs to interpret the signals (Hogg, Reeves, Roberts, & Mudford, 2001). In addition to the difficulties entailed in recognizing alertness, catching one of these alert moments to perform an activity is another challenge for DSPs. Individuals of the target group often show short periods of alertness with quick and irregular changes between "being alert" and "not being alert" (Guess et al., 1999; Munde, 2011).

Moreover, DSPs are not quite sure how to promote the levels of alertness that are optimal for learning and development (Guess et al., 1999; Mattie & Kozen, 2007). Previous studies have shown that external stimulation can have a larger impact on the level of alertness than internal conditions (Foreman, Arthur-Kelly, Pascoe, & King, 2004; Guess et al., 1999). At the same time, studies investigating the impact of different treatment activities on the level of alertness revealed contradictory results (Munde, 2011). Consequently, further clarification of the relationship between the level of alertness and different types of stimulation is needed.

These different types of stimulation can be divided into close and distant stimuli (Bergeest, Boenisch, & Daut, 2011). While tactile and vestibular stimuli, as well as smell and taste, are provided close to the body (close stimuli), visual and auditory stimuli have to be presented in the environment of a person (distant stimuli). Because close stimuli are already dominant in the first months of a child's life, they have been described as "unconditional" (Fröhlich, 1991; Ottenbacher & Petersen, 1985). Because the developmental age of individuals with PIMD is often determined at the level of up to 24 months, these stimuli are also expected to fit the needs and abilities of individuals with PIMD. At the same time, vestibular stimulation in particular is supposed to be important as a starting point for all types of stimulation, given that vestibular stimulation is the first experience of a child during gestation. Thereby, vestibular stimulation can be defined as any movement that stimulates the vestibular receptors. The vestibular receptors for their part serve to regulate posture, equilibrium, muscle tone, and the orientation of the head and body in space (Ottenbacher & Petersen, 1985). After an individual has experienced this basic form of stimulation, other types of stimuli (such as visual and auditory) can be introduced. Distant stimuli can, in a subsequent step, help an individual with PIMD to engage with the environment (Fröhlich, 1991). However, these suggestions have not been supported to date by empirical research results.

Only a small number of previous studies have empirically investigated the relationship between alertness in individuals with PIMD and different types of stimuli. Focussing on multisensory stimulation, authors formulated different conclusions. Lindsay and her colleagues (1997) compared the level of alertness following four different treatment activities and found higher levels of alertness following multisensory stimulation and relaxation in contrast to hand massage/ aromatherapy and active therapy on a bounce castle. While Ashby, Lindsay, Pitcaithly, Broxholme and Geelen (1995) also found high percentages of alertness during a task following multisensory stimulation, they express doubts about the direct relation between the stimulation and the behaviour in terms of alertness. Vlaskamp, de Geeter, Huijsmans and Smit (2003) did not find any differences in alertness reactions to the general living environment compared to multisensory environments. Looking more explicitly at distant stimulation, visual stimuli have been associated with high percentages of alert behaviour (Munde, 2011). This was especially true when these were combined with auditory stimulation. The authors of another study concluded that the use of tactile stimuli showed the highest alertness levels (Vlaskamp et al., 2003). Concerning vestibular stimuli, only a small number of studies is available. Comparing alertness reactions to different types of stimuli, another previous study has shown that reactions in terms of alertness to vestibular stimulation were *different* from other types of stimulation (Munde, 2011). Two studies focused on the therapeutic use of a trampoline. While the therapy did not reveal the highest levels of alertness in the comparison (Lindsay et al., 1997), Jones and her colleagues (2007) could demonstrate higher percentages of alert behaviours after therapy. Cuvo, May and Post (2001) as well as Lancioni and his colleagues (Lancioni, O'Reilly, Campodonico, & Mantini, 1998; Lancioni, O'Reilly, & Mantini, 1999) investigated the impact of active versus passive activities. Thereby, active activities included movement in space, while passive activities were provided at a static location. All three studies found higher percentages of alertness during those activities including movement and thus vestibular stimulation. Furthermore, the results of the only study looking at the relationship between vestibular stimulation and visual/auditory alertness during a task following on this stimulation were inconclusive (Sandler & Voogt, 2001). This multiple case study investigated the visual/auditory alertness of six children with PIMD during eight different tasks following a short period of vestibular stimulation (rocking in an adapted swing) or following a stationary condition (sitting in the adapted swing without rocking). The results showed that the performance of the children on all but one of the tasks did not differ vis-à-vis the conditions: It was predominantly the same for both. Still, the suggestion that vestibular stimulation prior to other forms of stimulation may help a person to become more alert adds weight to the importance of this type of stimulation.

To provide the empirical evidence that is lacking, the present study aims to clarify the relationship between distant stimulation following vestibular stimulation and alertness in individuals of the target group. The following three research questions have been formulated:

- *What is the level of alertness in individuals with PIMD during vestibular stimulation?*

- *What is the difference between the levels of alertness in individuals with PIMD during vestibular stimulation compared to visual/auditory stimulation?*
- *What is the difference between the levels of alertness in individuals with PIMD during visual/auditory stimulation compared to the level of alertness during visual/auditory stimulation that follows upon vestibular stimulation?*

Method

Design

The present study was based on a quasi-experimental design. The independent variable was the stimulation which can be subdivided into three levels representing the three experimental conditions: visual/auditory, vestibular, and visual/auditory following vestibular; the dependent variable was the level of alertness.

Participants

All special schools for students with PIMD located in Baden-Würtemberg, a state in southern Germany, were invited to participate in the present study. In the end, eight schools indicated that they had students with PIMD to whom they were providing vestibular stimulation prior to distant stimulation. Between one and four students from each school were included, with a total of 21 participants. The sample was based on the choice of the teachers (all DSPs included in the present study were teachers). Because no formal ethical approval is required for educational studies in Germany and the participants of our study were not able to approve their participation themselves, informed consent of the parents or legal representatives was gathered. Six girls and fifteen boys participated in the study. Their age ranged from 7 to 25 years, with a mean age of 15.3. All participants could be described as individuals with PIMD according to the definition of Nakken and Vlaskamp (2007). While 15 participants had visual impairments, all were also diagnosed with some form of auditory impairment. Thirteen participants had epilepsy. An overview of the characteristics of the participants is given in Table 1.

Insert about here: Table 1.

Instrument

The Alertness Observation List (AOL; Vlaskamp, Fonteine, Tadema, & Munde, 2010) was used to determine the level of alertness. The observation list distinguishes four levels of alertness, each of which is associated with a colour: 1) active, focused on the environment (green); 2) inactive, withdrawn (orange); 3) sleeping, drowsy (red); and 4) agitated, discontented (blue). To take into account the large differences in preferences and abilities between individuals with PIMD, an individual alertness profile is necessary. Therefore, information is recorded on four different forms. Filling in the first form, the observer determines the overall state of the individual with PIMD. Only if the individual experiences a "normal" day (i.e. without illness, unusual epileptic seizure or new medication), subsequent observations will be conducted. On the second form, alertness levels are scored during an entire day. This observation especially aims to determine the preferred moment of the day of the individual with PIMD for stimulation. The third form, then, comprises a detailed observation of an individual activity. Based on this observation, descriptions of preferred content of stimulation, way of presenting, and individual alertness expressions can be formulated. In the alertness profile (the fourth form), all information gathered in the observations is combined. An example of an individual alertness profile is displayed in Figure 1.

Insert about here: Figure 1.

Based on previous studies, the AOL can be described as a reliable instrument for determining alertness in individuals with PIMD. Scorings of a sample of 78 videotapes from 23 children with PIMD revealed that both inter-observer and intra-observer agreement exceeded the 80% criterion (Munde, 2011). Furthermore, similarities between the alertness observations using the AOL and physiological measurements have led to the assumption that the instrument fulfils the aim of determining alertness and is, thus, valid (Munde, 2011).

Procedure

Data for the present study was gathered in two steps. First, the AOL was completed for all participants. For every participant, a teacher who had known the student for at least six months conducted the observations and formulated the individual alertness profile. Second, three different situations were videotaped for each participant. In situation 1, the teacher who completed the AOL provided visual and/or auditory stimulation to the student; in situation 2, vestibular stimulation was provided. Situation 3 comprised the presentation of visual and/or auditory stimuli again, but in this case vestibular stimulation had been presented prior to the situation. The three situations for one participant were always presented in the same week. The situations were presented in an at random order with at least 15 minutes between the situations to avoid carry-over effects. The teachers were instructed to consider the individual's alertness profile when choosing a moment during the day and the stimuli. The moment of the day had to be based on the preferences of the individual participant in order to allow for the best possible reaction; the choice as well as the duration of the stimulus had to be based on the preferences of the individual participant in order to include only stimuli that were expected to be salient for the participant and, therefore, would increase the participant's alertness. Consequently, the stimuli presented were not similar for the different participants, but were comparable in terms of salience. Examples of vestibular stimuli are rocking in a wheelchair swing, bouncing on a big ball, or moving in a large rocking bowl. Visual and auditory stimuli could, for example, be watching a coloured light, and listening to music, respectively. In addition, an adapted duration of the stimulation would meet the individual's needs in terms of processing time and would, at the same time, not ask too much from the participant. The length of the activity varied between 1 and 35 minutes. Based on the knowledge of the teachers, all situations were judged representative for the daily experiences and reactions of each participant. Table 2 and 3 provides an overview of the actual stimuli presented and the actual length of the stimulation for each participant.

Insert about here: Table 2 and 3.

The videotapes were scored by three observers. All of these observers were familiar with the aim of the study and had been trained in the use of the AOL. The training consisted of three parts: 1) a theoretical introduction of the topics "individuals with PIMD," "alertness," and "observations," 2) information about the structure and use of the observation instrument, and 3) practical training for the use of the AOL. Only when the observers had reached an inter-observer agreement of more than 80% for the observation exercise, were they started observing the videotapes of the present study. Individual alertness profiles were employed as frameworks for determining alertness levels. For scoring purposes, the alertness level "alert" was subdivided into two levels (i.e., "active-alert" and "passive-alert"), in order to separate reactions including or excluding motor action. Thereby, "active-alert" included behaviours such as grasping, reaching or bouncing; in contrast, "passive-alert" was scored when behaviours such as listening, watching or making sounds occurred. To calculate the inter-observer agreement, 20% of the tapes were scored independently by a second observer who was not part of the main research team. Employing the general agreement formula (Mudford et al., 1997) revealed an average agreement of 83% with a standard deviation of 12,34. Percentages for the individual situations ranged from 67 to 100%.

Analysis

All analyses were conducted in SPSS 17. First, we explored the data by using descriptive statistics. Percentages of the occurrence of the various alertness levels in the three conditions revealed a general picture of the data. In addition, the relation between these percentages and the duration of the stimulation were described. Furthermore, we compared the percentages of the alertness levels for several subgroups based on the characteristics of the participants (gender, age groups, visual impairment, and epilepsy). Because of the small sample size, medians of the distributions were calculated. Second, statistical tests were employed in order to strengthen the answers to the research questions. Only those data were included which were directly related to the answers of research questions to avoid a reduction of power (Corder & Formena, 2009). Non-parametric statistics were necessary because of the violation of several assumptions for parametric tests (Corder & Foreman, 2009). In the present study, an ordinal variable was investigated in a small sample resulting in extremely skewed data. The Related Samples Friedman's Two-Way Analysis of Variance by Ranks was used to estimate the differences in occurrence of the five different alertness levels during vestibular stimulation. Then, differences between the conditions were estimated using the Related Samples Wilcoxon Signed Rank Test. To diminish the problem of multiple comparisons (Corder & Foreman, 2009), only those alertness levels were included which had already revealed large differences between the conditions in the descriptive analysis. Differences between the vestibular condition and the visual/auditory condition, and between the visual/auditory condition with and without prior vestibular stimulation were estimated. All statistical tests are based on the means of the distributions. We employed a significance level of $p<0.05$ for all tests.

Results

Vestibular stimulation

During vestibular stimulation, the participants were mostly active-alert or passive-alert (30% and 46% of the time, respectively). While withdrawn behaviour occurred 6% of the time, no sleep or agitated behaviour was observed. Furthermore, large individual differences were present when comparing percentages of alert (active-alert and passive-alert) and withdrawn behaviour (see Table 4 and Figure 2). No clear pattern in the percentages of occurrence of the different alertness levels across different durations of the stimulation became apparent.

Insert about here: Table 4 and Figure 2

Looking at the relation between the alertness reactions and the characteristics of the participants, results differed for the different subgroups. Both boys and girls were mostly passive-alert (46 and 39%, respectively) during vestibular stimulation. However, boys were only active-alert (35%) during the remaining time of the stimulation, whereas girls were either active-alert (17.5%) or withdrawn (11%, see Figure 3). Furthermore, the participants between 18 and 25 years showed different reactions than the younger ones. While the younger individuals showed similar percentages of active-alert and passive-alert behaviour (35 and 47%, respectively for the age group 7-14 years, and 30 and 27.5% for the age group 15-17 years), the results of the participants between 18 and 25 years revealed high percentages of passive-alert behaviour (59.5%) compared to relatively low percentages of active-alert behaviour (29%, see Figure 4). Individuals with severe visual impairments were mostly active-alert (55.5%); individuals with mild visual impairments were mostly passive-alert (55.5%); and individuals without visual impairment showed high percentages for both active-alert and passive-alert behaviour during vestibular stimulation (30 and 46%, respectively, see Figure 5). Also results for individuals with and without epilepsy revealed a difference. While those with epilepsy showed clearly more passive-alert behaviour (47% compared to 24% active-alert behaviour), those without epilepsy showed slightly more active-alert behaviour (32.5% compared to 24.5% passive-alert behaviour, see Figure 6).

Insert about here: Figure 3, 4, 5, and 6.

The Related Samples Friedman's Two-Way Analysis of Variance by Ranks revealed significant differences between active-alert and passive-alert behaviour compared to sleep and agitated behaviour ($X^2(2)= 33.920$, $p= .000$). All other comparisons were not significant. An overview of all results of the test is presented in Table 5.

Insert about here: Table 5.

Vestibular stimulation compared to visual/auditory stimulation

While the participants were slightly more active-alert during visual/auditory stimulation compared to vestibular stimulation (33% versus 30%), they were more passive-alert during vestibular stimulation than during visual/auditory stimulation (46 % versus 31%). Withdrawn behaviour occurred slightly more often during visual/auditory stimulation (with 8% compared to 6% during vestibular stimulation). Again, large standard deviations of percentages of alert (active-alert and passive-alert) and withdrawn behaviour show large individual differences in both conditions (see Table 4 and Figure 2). While no asleep and agitated behaviour was observed during either types of stimulation, on average, looking back at the individual results makes a clarifying remark necessary. During the visual/auditory stimulation, five participants were asleep for up to 41% of the time, compared to nearly no sleep during vestibular stimulation. In addition, five other participants were agitated during vestibular stimulation for up to 38% of the time, with nearly no agitated behaviour during visual/auditory stimulation. No clear pattern in the percentages of occurrence of the different alertness levels across different durations of the stimulation became apparent.

Looking at the relation between the alertness reactions and the characteristics of the participants, no substantial differences in reactions between boys and girls have been found (see Figure 3). In contrast, the participants of two age groups showed a different pattern in the two conditions. Individuals between 7-14 years were slightly more passive-alert during vestibular stimulation (47% compared to 35% of active-alert behaviour) and slightly more active-alert during visual/auditory stimulation (44% compared to 31% of passive-alert behaviour). The participants between 18-25 years were mostly passive-alert during vestibular stimulation (59.5%), while percentages for active-alert, passive-alert and withdrawn behaviour were similar in the condition with visual/auditory stimulation (25, 23.5, and 21.5%, respectively). For the other participants, no clear differences between alertness levels and conditions have been found (see Figure 4). Patterns in the occurrence of the different alertness levels only differed for those individuals without visual impairments. While high percentages for both active-alert and passive-alert behaviour have been found during vestibular stimulation (30 and 46%, respectively), individuals without visual impairments were mostly active-alert during visual/auditory stimulation (43%). For those participants with (mild and severe) visual impairments, no substantial differences between the two conditions became apparent (see Figure 5). Participants who had been diagnosed with epilepsy were mostly passive-alert during vestibular stimulation (47%) compared to those without epilepsy who showed high percentages of active-alert behaviour during visual/auditory stimulation (55%). For individuals with epilepsy during visual/auditory stimulation and individuals without epilepsy during vestibular stimulation, percentages of active-alert and passive-alert behaviour were almost equal (28 and 31%, and 32.5 and 24.5% respectively, see Figure 6).

Because only the descriptive statistics of passive-alert behaviour revealed large differences between the two conditions, only these percentages were tested. The results of the Related Samples Wilcoxon Signed Rank Test did not reveal a significant difference between the percentage of passive-alert behaviour during vestibular stimulation compared to visual/auditory stimulation (*Z*= -0.487, *p*=.626).

Visual/auditory stimulation compared to visual/auditory stimulation following vestibular stimulation

When visual/auditory stimulation was provided after vestibular stimulation, participants showed active-alert behaviour 44% of the time, compared to 33% during visual/auditory stimulation without prior vestibular stimulation. Percentages for passive-alert behaviour were 24% for the combination of visual/auditory stimulation and vestibular stimulation versus 31% for visual/auditory stimulation alone. While participants were withdrawn 8% of the time during visual/auditory stimulation without prior vestibular stimulation, no withdrawn behaviour occurred when visual/auditory stimulation was provided following vestibular stimulation. Sleep and agitated behaviour did not occur in any of the situations. However, the large standard deviation for agitated behaviour during visual/auditory stimulation following vestibular stimulation shows that large individual differences were present (see Table 4 and Figure 2). Again, a clarifying remark is necessary based on the individual results. Almost no withdrawn behaviour was observed during the condition of visual/auditory stimulation following vestibular stimulation. At the same time, seven participants were very much alert (71% to 100% of the time). Furthermore, three participants showed high (84% to 100%) percentages of agitated behaviour compared to nearly no agitated behaviour under the visual/auditory stimulation condition alone. No clear pattern in the percentages of occurrence of the different alertness levels across different durations of the stimulation became apparent.

Looking at the relation between the alertness reactions and the characteristics of the participants, results differed for the two conditions. For boys and girls, similar distributions of the occurrence of the different alertness levels were observed during visual/auditory stimulation alone. Thereby, both were mostly passive-alert (42 and 45%, respectively). In contrast, when vestibular stimulation preceded the visual/auditory stimulation, boys were mostly active-alert (62%) with only small percentages of passive-alert behaviour (20%). Girls were still mostly passive-alert (37%), but slightly more active-alert behaviour was observed than during visual/auditory stimulation alone (19% compared to 14.5%). Participants between 7-14 years showed almost only active-alert behaviour (44% with only 4% of passive-alert behaviour) when vestibular stimulation preceded the visual/auditory stimulation compared to similar percentages of active-alert and passive-alert behaviour during visual/auditory stimulation alone (44 and 31%, respectively). While participants between 18-25 years showed almost equal percentages of active-alert, passive-alert and withdrawn behaviour (25, 23.5, and 21.5%, respectively) during visual/auditory stimulation alone, high percentages of only active-alert and passive-alert behaviour (42 and 50.5%) became apparent, when the stimulation was preceded by vestibular stimulation. For the other participants, no clear differences between alertness levels and conditions have been found (see Figure 4). Furthermore, the distributions of the occurrence of the different alertness levels were similar in both conditions for participants with severe, mild or no visual impairment. Still, two results should be pointed out. First, individuals with mild visual impairments were mostly passive-alert during visual/auditory stimulation alone (50%), whereas similar percentages of active-alert and passive-alert behaviour were observed during visual/auditory stimulation following vestibular stimulation (20.5 and 17.5%, respectively). Second, individuals without visual impairments were mostly active-alert in both conditions. However, percentages of active-alert behaviour clearly exceeded the percentages of the other alertness levels during visual/auditory stimulation alone (43% compared to 6% of passive-alert behaviour). When vestibular stimulation preceded the visual/auditory stimulation, these individuals also showed high percentages of passive-alert behaviour (39%). Also results for individuals with and without epilepsy revealed a difference. While individuals without epilepsy showed similar reactions in both conditions, individuals with epilepsy were clearly more active-alert during visual/auditory stimulation following vestibular stimulation (56%) compared to visual/auditory stimulation alone (28%).

Because only the descriptive statistics of active-alert behaviour revealed large differences between the two conditions, only these percentages were tested. The results of the Related Samples Wilcoxon Signed Rank Test did not reveal a significant difference between the percentage of active-alert behaviour during visual/auditory stimulation with or without prior vestibular stimulation (Z= 1.242, p=.214).

Discussion

The aim of the present study was to clarify the relationship between distant stimulation following vestibular stimulation, and alertness in individuals with PIMD. Therefore, alertness observations under three conditions (vestibular stimulation, visual/auditory stimulation, and visual/auditory stimulation following vestibular stimulation) were compared. The descriptive results revealed high percentages of active-alert behaviour in situations when visual/auditory and vestibular stimulation were combined. In contrast, the participants showed almost equal percentages of active-alert and passive-alert behaviour during visual/auditory stimulation alone and mostly passive-alert behaviour during vestibular stimulation alone. However, these differences were not statistically significant. Only the occurrences of the different alertness levels within these conditions differed significantly. While only very small percentages of sleep and agitated behaviour were observed, those differed significantly from the high percentages of alert (active-alert and passive-alert) behaviour within all three conditions. This result gives credence to the previous finding that stimulation in and of itself can lead to an increased level of alertness (Guess et al., 1999; Munde, 2011).

At the same time, large individual differences in duration of and reactions to the three conditions have been found. While one of the stimulation situations for three participants only endured for 1 minute, two other participants were provided with a stimulation situation for 35 minutes. However, no patterns in alertness reactions related to the different duration could be found. When we looked at the reactions based on several characteristics of the participants, large differences between subgroups became apparent. While an explanation for these differences in reactions might be found in the individual differences in needs and abilities (Mudford et al., 1997; Munde, 2011), the individual differences in duration of and reactions to the stimulation may explain the non-significant results when comparing the three different conditions.

Still, zooming in on the large individual differences leads to several additional explanations of our findings. Participants between 7-14 years and between 18-15 years as well as those participants who were diagnosed with epilepsy were more passive-alert during vestibular stimulation compared to visual/auditory stimulation. However, girls and participants without visual impairments were also withdrawn or agitated when confronted with vestibular stimuli. Possibly, some individuals with PIMD may need quite intense stimulation to become alert, while others can be quickly overwhelmed by the same type of stimulation.

In addition, visual/auditory stimulation following vestibular stimulation led to higher percentages of active-alert behaviour than visual/auditory stimulation alone in boys, participants between 7-14 years and participants with epilepsy. At the same time, some of these participants were withdrawn during visual/auditory stimulation alone. For these individuals, we may suggest that a period of vestibular stimulation before starting an activity can "prepare" the individual with PIMD for the following activity.

When interpreting the results of the present study, some limitations have to be taken into account. Although our study included a relatively large number of participants compared to others studies about individuals with PIMD, all were said to have auditory impairments. Interestingly, this is not in line with epidemiological research findings on the overall target population (Evenhuis et al., 2001). In addition, no further differentiation concerning auditory impairments was therefore possible.

Furthermore, the types of stimuli were predefined, but the final stimulus, the way of presenting it, and the way of interacting with the teacher was different for each participant. Additionally, the length of the activity was left up to the teacher to define. While this may make the situations less comparable to each other, individualised stimulation is especially important for individuals of the target group. Consequently, teachers were instructed to act in such a way as to adapt to the needs and abilities of the individual with PIMD. In the end, stimuli were judges to be comparable in terms of salience for all participants. At the same time, future studies including a case series or a more experimental design (with matched pairs of participants or stricter inclusion criteria) may reveal information that is supplementary to the present results about the type and intensity of the stimulus, and the length of the activity.

Another limitation might be seen in the non-blinded observers. However, previous studies showed that information about the observed individuals and context information is especially important when investigating individuals with PIMD (Hogg et al., 2001; Munde, 2011). Still, including a comparison of the outcomes of blinded and non-blinded observers may also complement our present findings.

The results of the present study have several implications for the support of individuals with PIMD in daily clinical practice. There is not *one* way of presenting vestibular stimulation for all individuals with PIMD. As stated previously, the large heterogeneity is one of the main characteristics of the target population (Nakken & Vlaskamp, 2007). Consequently, DSPs can be advised to take these individual differences into account when looking at the alertness reactions of an individual with PIMD. Assessing the individual's alertness in relation to different types of stimulation can be a first step. DSPs should, thereby, be aware of the possible impact of the characteristics of the individual with PIMD, such as gender, age, visual impairment, or epilepsy. In a second step, alertness observations after modifying the stimulation can reveal additional information. Finally, reactions to combinations of stimulation can be assessed. Based on the information gathered during the assessment, DSPs can adapt the stimulation situations to the individual needs and preferences.

Because of the large differences in alertness reactions, vestibular stimulation should always be presented in a well thought-out way. As suggested earlier, gentle rocking may calm one person and lead to passive alertness, while considerable swinging may make another person more active-alert (Fröhlich, 1991). Vestibular stimulation during a prolonged period of time and of high intensity may be overwhelming for some individuals of the target group. Only when the stimulation fits the needs and abilities of an individual with PIMD, can it help an individual to become and stay alert, and to engage with the environment.

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Tables

Table 1

Characteristics of the participants

	Gender	Age	Epilepsy	Visual impairment	Auditory impairment
1	male	25	x	x	X
2	female	15		x	X
3	male	22	x		X
4	male	16		x	X
5	female	18			X
6	female	23	x	x	X
7	female	12	x	x	X
8	male	16		x	X
9	male	7	x	x	X
10	male	14		x	X
11	female	8	x	x	X
12	female	15	x	x	X
13	male	17	x		X
14	male	17		x	X
15	male	9	x	x	X
16	male	10	x		X
17	male	8		x	X
18	male	17	x		X
19	male	19	x	x	X
20	male	18		x	X
21	male	15	x		X

Table 2

Content of the stimulation for each participant

	Visual/auditory stimulation	Vestibular stimulation
1	Watching coloured toys	Assisted standing and rocking
2	Listening to the sound of a bell	Moving in a large rocking bowl
3	Watching a coloured light	Bouncing on a big ball
4	Listening to music	Rocking in a wheelchair swing
5	Listening to music	Rocking in a hammock
6	Listening to the sound of a singing bowl	Rocking on a board
7	Listening to the sound of a triangle	Rocking in a hammock
8	Watching coloured toys	Rocking on a board
9	Listening to music	Moving in a large rocking bowl
10	Watching coloured toys	Assisted standing and rocking
11	Listening to the sound of a drum	Bouncing on a big ball
12	Listening to the sound of a guitar	Moving in a large rocking bowl
13	Listening to music	Rocking in a wheelchair swing
14	Listening to the sound of a bell	Rocking in a swing
15	Watching coloured toys	Rocking in a wheelchair swing
16	Watching a coloured light	Moving on a trampoline
17	Listening to music	Assisted standing and rocking
18	Watching a coloured light	Moving on a trampoline
19	Watching a coloured light	Moving on a trampoline
20	Listening to the sound of a guitar	Bouncing on a big ball
21	Listening to music	Moving on a trampoline

Table 3

Duration of the stimulation for each participant

	Visual/auditory stimulation	Vestibular stimulation	Visual/auditory stimulation following vestibular stimulation
1	6,53	8,55	8,41
2	5,29	11,16	3,46
3	6,20	13,00	4,05
4	1,00	8,00	1,00
5	13,06	11,29	1,23
6	14,07	6,22	1,43
7	3,26	9,00	1,01
8	22,12	7,26	Missing
9	12,55	8,21	2,44
10	10,07	6,03	23,42
11	8,55	9,47	3,17
12	4,50	11,39	3,48
13	6,57	12,57	Missing
14	12,44	10,02	5,06
15	4,47	12,57	5,22
16	34,14	11,03	1,35
17	13,58	2,04	2,02
18	35,00	17,19	2,34
19	29,16	6,04	1,00
20	9,41	17,24	13,28
21	7,37	5,00	3,01

Table 4

Percentages of alertness during vestibular stimulation, visual/auditory stimulation, and visual/auditory stimulation following vestibular stimulation

Level of alertness	**Vestibular stimulation**	**Visual/auditory stimulation**	**Visual/auditory stimulation following vestibular stimulation**
Active-alert	0.36/0.30 (0.33)	0.36/0.33 (0.29)	0.45/0.44 (0.38)
Passive-alert	0.38/0.46 (0.28)	0.34/0.31 (0.26)	0.31/0.24 (0.33)
Withdrawn	0.20/0.06 (0.28)	0.22/0.08 (0.26)	0.06/0.00 (0.12)
Asleep	0.01/0.00 (0.03)	0.05/0.00 (0.11)	0.02/0.00 (0.06)
Agitated	0.03/0.00 (0.09)	0.00/0.00 (0.02)	0.15/0.00 (0.35)

Note. Means/medians of percentages of observed alertness are given complemented by standard deviations (in parentheses). The highlights indicate which percentages of the observations were entered in the non-parametric tests: The gray box includes all percentages used for the Related Samples Friedman's Two-Way Analysis of Variance by Ranks; the two boxes with black outlines include the percentages used for the two Related Samples Wilcoxon Signed Rank Tests.

Table 5

Results of the Related Samples Friedman's Two-Way Analysis of Variance by Ranks (pairwise comparison, adjusted significances)

Compared alertness levels	P-value
Active-alert – passive-alert	1.000
Active-alert – withdrawn	1.000
Active-alert – asleep	0.005*
Active-alert – agitated	0.009*
Passive-alert – withdrawn	0.404
Passive-alert – asleep	0.000*
Passive-alert – agitated	0.000*
Withdrawn – asleep	0.218
Withdrawn – agitated	0.318
Asleep – agitated	1.000

* p<0.05

Figures

Figure 1:

Example of an individual alertness profile based on the AOL (Vlaskamp et al., 2010)

Active, focused on the surroundings	**Examples of concrete behaviors**
Emily is primarily active and focused on her surroundings in the morning. She has poor vision and demonstrates that she is active by listening and feeling. She reacts most strongly to tactile stimuli. Emily is largely focused on her caregivers. If you remain close to her	Emily turns her face toward sound, her eyes are clear, and she smiles almost constantly. She makes noises when she is touched. She also touches the caregiver. She holds and touches objects.

and do not interrupt the tactile contact, she can remain alert for about 1-5 minutes.	
Turned inward	**Examples of concrete behaviors**
Emily is usually turned inward for extended periods after eating or after other activities (e.g., physical therapy). At these times, she is largely focused on her hands, with considerable rubbing and pulling.	Emily picks (with thumb and forefinger) at her clothing, puts her thumb in her mouth, makes growling noises, and rubs her eyes.
Sleeping, napping	**Examples of concrete behaviors**
Emily does not sleep deeply during the day. She does have periods of dozing, particularly following therapy or group activities.	Emily sits very quietly, and repeatedly opens and closes her eyes slowly.
Agitated, discontent	**Examples of concrete behaviors**
Emily sometimes cries loudly when things become "too much" for her. Bouts of crying occur mostly in the afternoon.	Emily cries in long periods of wailing, but without tears. If she does not receive attention immediately, she starts biting the ball of her hand.

Figure 2:

Medians of the percentages of alertness during vestibular stimulation, visual/auditory stimulation, and visual/auditory stimulation following vestibular stimulation

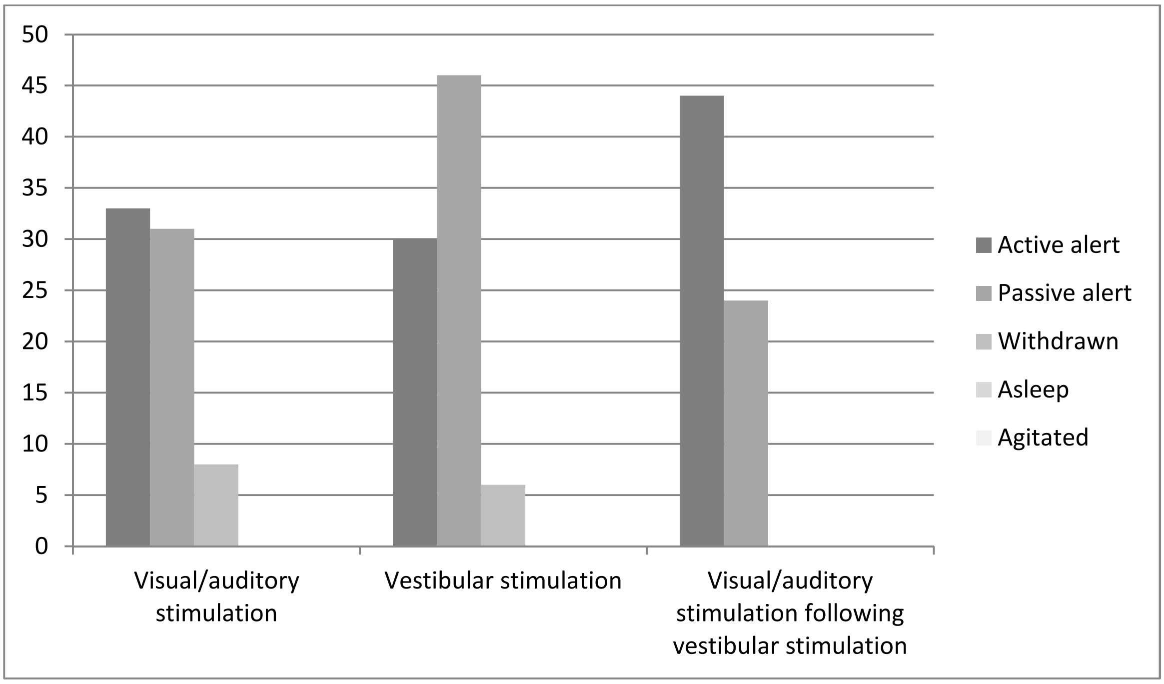

50
45
40
35
30
25
20
15
10
5
0
Active alert
Passive alert
Withdrawn
Asleep
Agitated
Visual/auditory stimulation
Vestibular stimulation
Visual/auditory stimulation following vestibular stimulation

Figure 3:

Medians of the percentages of alertness during visual/auditory stimulation, vestibular stimulation, and visual/auditory stimulation following vestibular stimulation for boys and girls

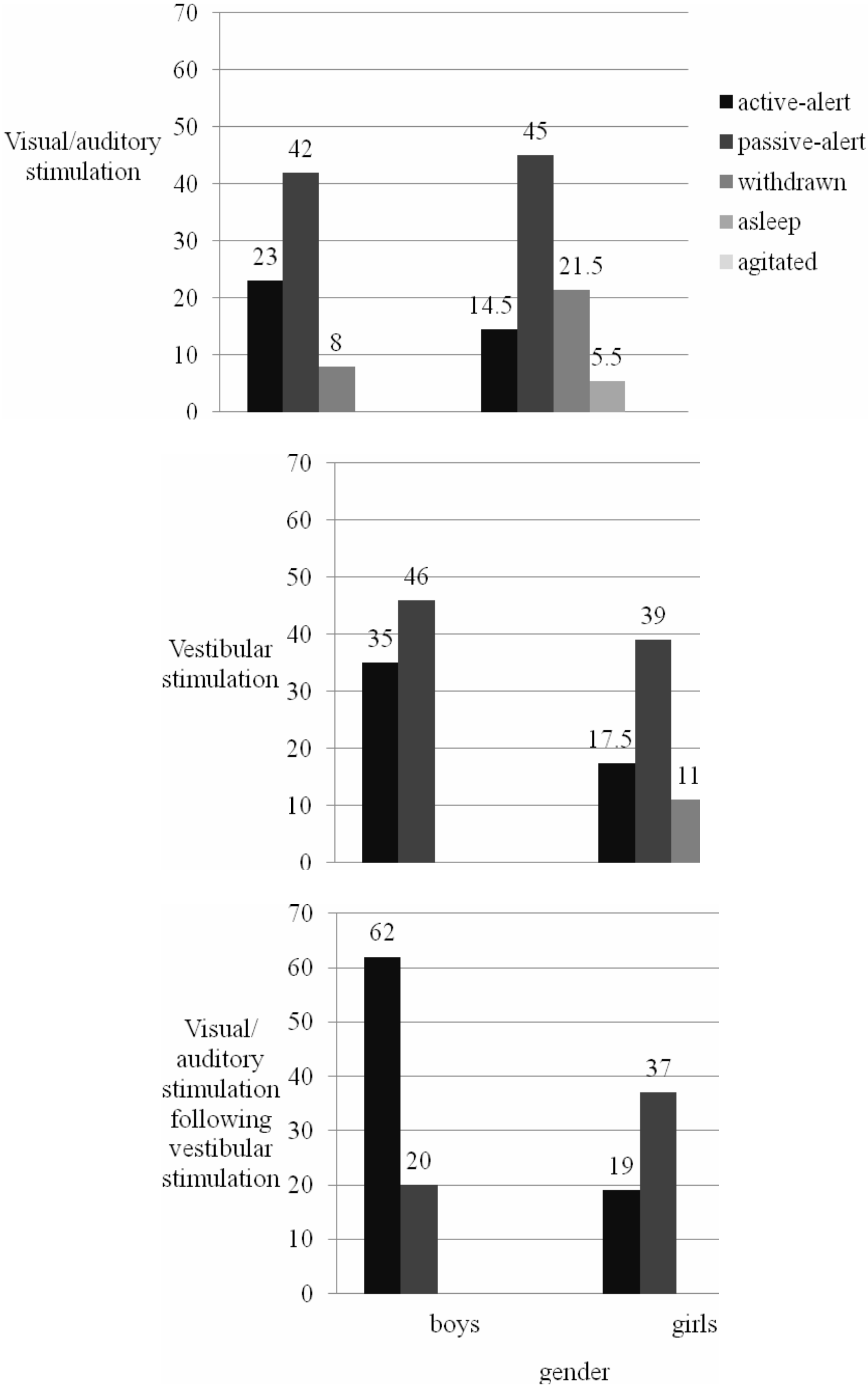

Visual/auditory stimulation
70
60
50
40
30
20
10
0
23
42
8
14.5
45
21.5
5.5
active-alert
passive-alert
withdrawn
asleep
agitated
Vestibular stimulation
35
46
17.5
39
11
Visual/ auditory stimulation following vestibular stimulation
62
20
19
37
boys
girls
gender

Figure 4:

Medians of the percentages of alertness during visual/auditory stimulation, vestibular stimulation, and visual/auditory stimulation following vestibular stimulation for different age groups

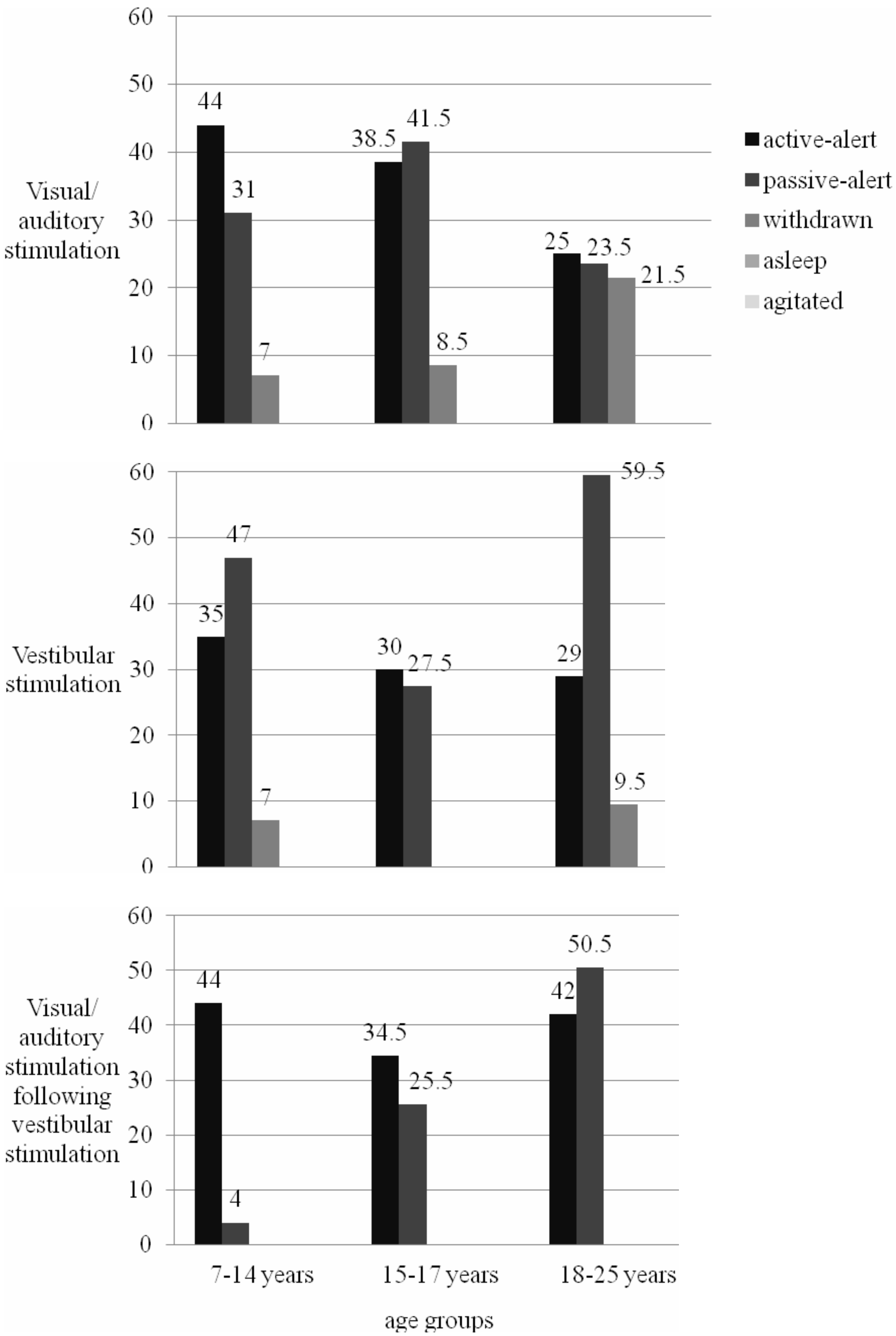

Visual/ auditory stimulation
Vestibular stimulation
Visual/ auditory stimulation following vestibular stimulation
active-alert
passive-alert
withdrawn
asleep
agitated
44
31
7
38.5
41.5
8.5
25
23.5
21.5
35
47
7
30
27.5
29
59.5
9.5
44
4
34.5
25.5
42
50.5
0
10
20
30
40
50
60
7-14 years
15-17 years
18-25 years
age groups

Figure 5:

Medians of the percentages of alertness during visual/auditory stimulation, vestibular stimulation, and visual/auditory stimulation following vestibular stimulation for participants with severe or mild or without visual impairment

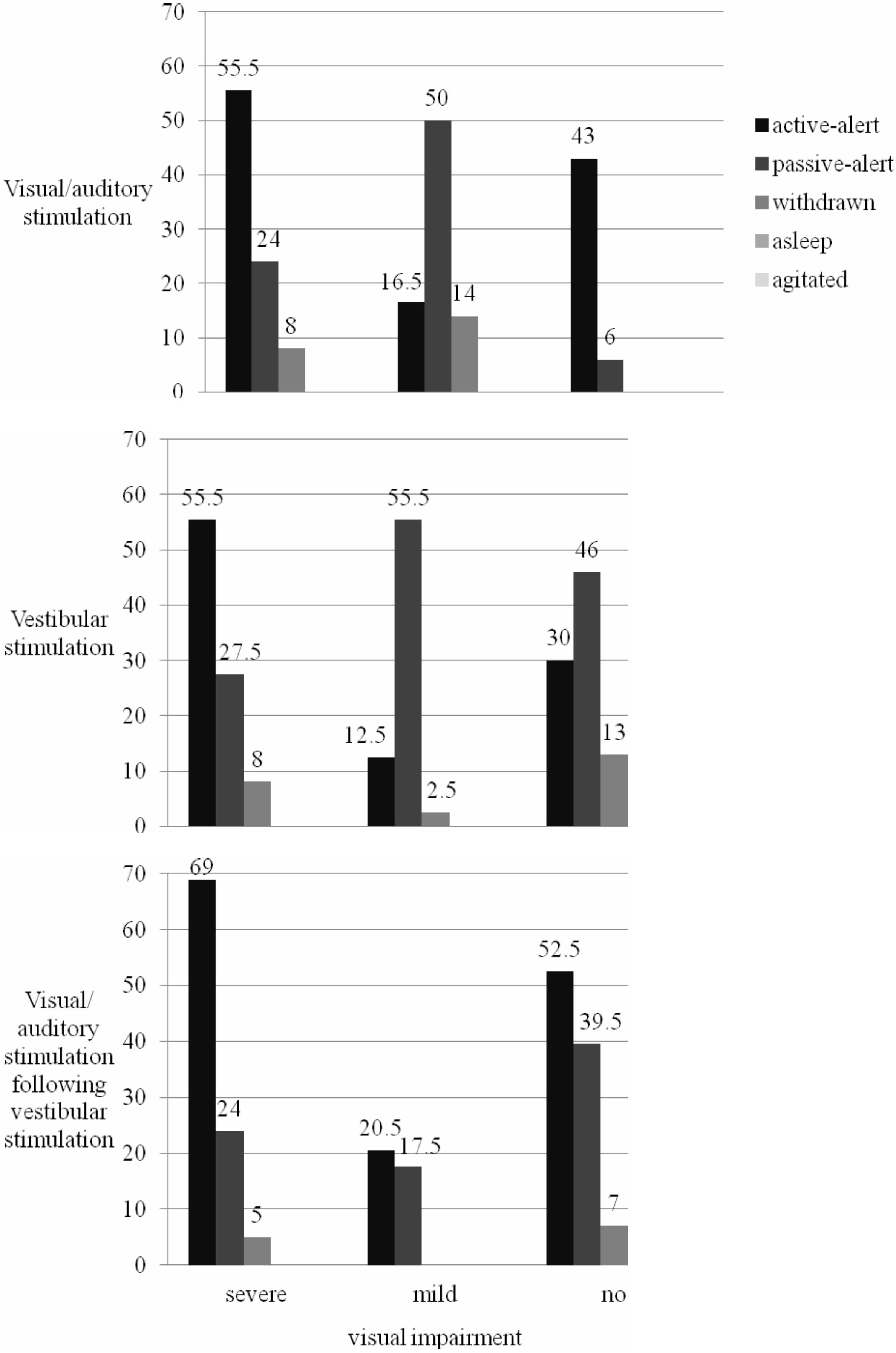
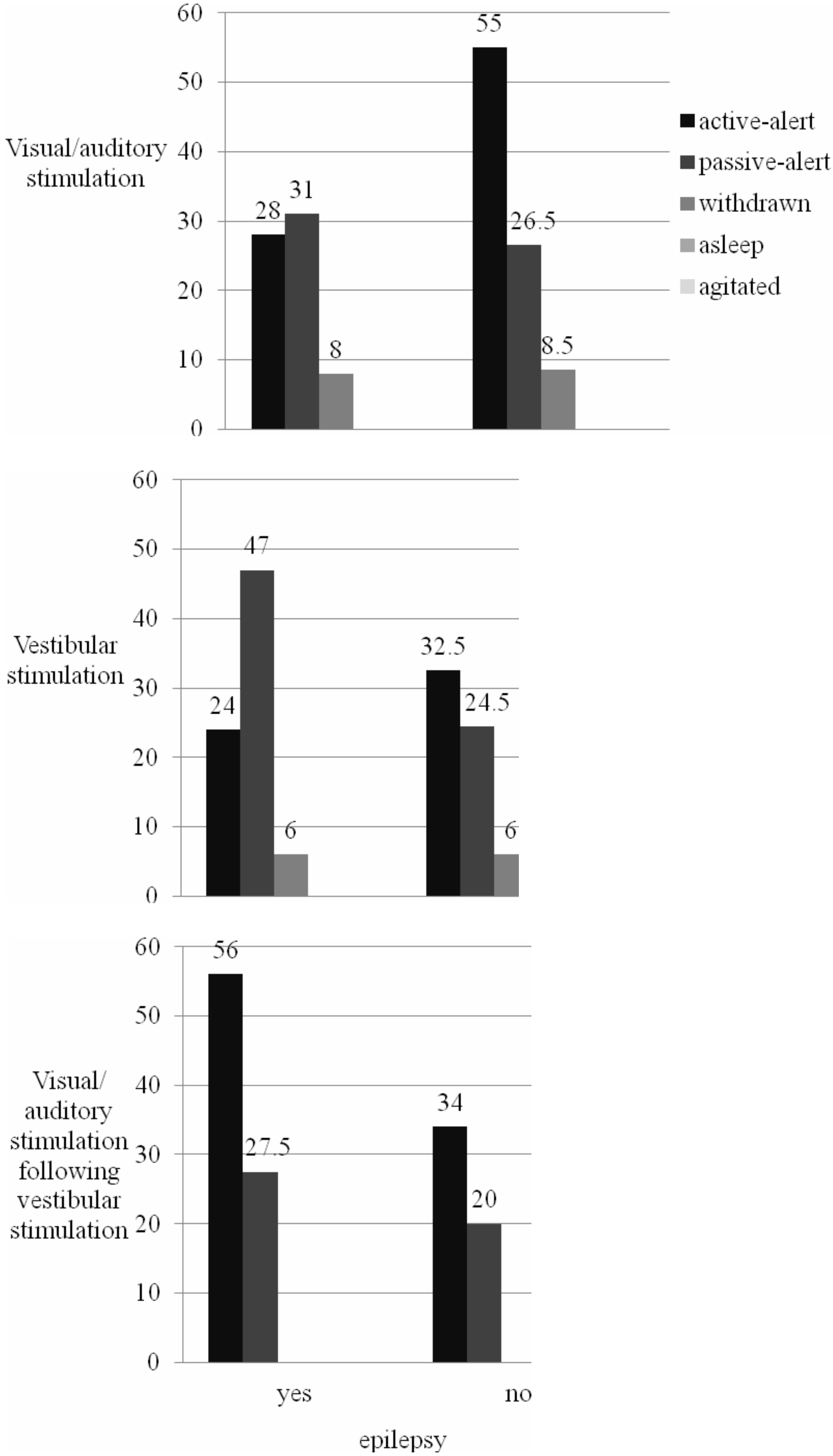

Visual/auditory stimulation
70
60
50
40
30
20
10
0
55.5
24
8
16.5
50
14
43
6
active-alert
passive-alert
withdrawn
asleep
agitated
Vestibular stimulation
55.5
27.5
8
12.5
55.5
2.5
30
46
13
Visual/ auditory stimulation following vestibular stimulation
69
24
5
20.5
17.5
52.5
39.5
7
severe
mild
no
visual impairment

Figure 6:

Medians of the percentages of alertness during visual/auditory stimulation, vestibular stimulation, and visual/auditory stimulation following vestibular stimulation for participants with and without epilepsy


Visual/auditory stimulation
Vestibular stimulation
Visual/ auditory stimulation following vestibular stimulation
active-alert
passive-alert
withdrawn
asleep
agitated
60
50
40
30
20
10
0
28
31
8
55
26.5
8.5
24
47
6
32.5
24.5
6
56
27.5
34
20
yes
no
epilepsy