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REVIEW PAPER

Comorbid Deafblindness and Autism Spectrum Disorder—Characteristics, Differential Diagnosis, and Possible Interventions

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Abstract As the prevalence of autism spectrum disorder (ASD) increases, so has the escalation of the diagnosis of ASD individuals with deafblindness (DB). This literature review examines the characteristics of individuals with DB and those with ASD, overlapping characteristics of the two disorders, intervention practices used in each field, evidence-based practices (EBPs) used in each field, possibilities for differential educational diagnosis of comorbid DB and ASD, and educational implications.

Keywords Deafblind · Autism spectrum disorder · Evidence-based practices · Prevalence · Characteristics · Differential diagnosis

Introduction

The existence of the comorbidity of deafblindness (DB) and autism spectrum disorder (ASD) has been greatly disputed over the past decade. Studies indicate that DB is often missed (Fellinger et al. 2009). As the prevalence of ASD has grown in individuals with no additional disabilities, there exists a great possibility that the prevalence of ASD in the population of DB has grown as well; however, there are many factors to consider when diagnosing ASD in individuals with DB. Additionally, a strong literature base for evidence-based practices (EBPs) in the area of ASD exists; conversely, there is more limited literature which addresses EBPs for individuals who are deafblind. The purpose of this literature review is to investigate the available literature on DB as well as literature pertinent to EBPs used in the education of individuals who have comorbid DB and ASD. This review will particularly focus on any information available on this population as well as possible directions for educational practices. While EBPs have been the topic of much research over the past two decades in the area of ASD, there exists little literature base from which to draw upon regarding EBPs in the area of DB. Furthermore, when perusing literature for EBPs for use with individuals who have comorbid DB and ASD, there is a paucity of research available.

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Definitions and Prevalence of DB

When an individual has DB, they have little or no useful sight or hearing, but may have some residual hearing and/or vision (Dammeyer 2014; Miles 2008); however, there is great variation in the formal definition of DB (Larsen and Damen 2014). In the field of sensory impairment, professionals identify DB as a hearing loss in the better ear greater than 35 decibels and vision loss of less than 20/60; however, Evenhuis (1996) suggests using a more conservative hearing loss of greater than 25 decibels for individuals with comorbid intellectual disability (Fellinger et al. 2009). Nordisk Lederforum (2007) identified the distinct disability of DB as a comorbid vision and hearing disability that restricts the activities of a person and hampers full participation in society so much that specific services, environmental modifications, and/or technology are necessary. Using this definition, the classification of DB should not be determined by a medical assessment of only vision and hearing; rather, it must be accompanied by functional

evaluations of these senses to assess their usefulness for communication, information gathering, etc. (Dammeyer 2010).

In an attempt to define DB, some professionals use the legal definition which is constructed as a result of the dual sensory impairment assessments used. The 29 U.S. Code § 1905 stipulates that the legal definition of DB is any individual who:

(i) has a central visual acuity of 20/200 or less in the better eye with corrective lenses, or a field defect such that the peripheral diameter of visual field subtends an angular distance no greater than 20 degrees, or a progressive visual loss having a prognosis leading to one or both these conditions;
(ii) who has a chronic hearing impairment so severe that most speech cannot be understood with optimum amplification, or a progressive hearing loss having a prognosis leading to this condition; and
(iii) for whom the combination of impairments described in clauses (i) and (ii) cause extreme difficulty in attaining independence in daily life activities, achieving psychosocial adjustment, or obtaining a vocation (Sec. 206, para. 2).

The legal definition further designates that, for those individuals who are unable to have their hearing and vision accurately measured due to cognitive or behavioral limitations, their hearing and vision can be ascertained through functional and performance assessments. Additionally, individuals who have "severe hearing and visual disabilities that cause extreme difficulty in attaining independence in daily life activities, achieving psychosocial adjustment, or obtaining vocational objectives" (29 U.S. Code § 1905, para. 4) are considered DB. Lastly, anyone who meets other requirements determined by the Secretary of Education will be identified as DB.

Education professionals formulate their definition based upon the functioning of the child and the outcome of the comorbid condition (Larsen and Damen 2014). The Individuals with Disabilities Education Act (IDEA) states

> A child with DB has concomitant hearing and visual impairments, the combination of which causes such severe communication and other developmental and educational needs that they cannot be accommodated in special education programs solely for children with deafness or children with blindness (IDEA 300.8(c)(2)).

To further complicate the issue, literature also uses a wide variety of inclusionary definitions. At times, authors focus on the severity of sensory loss or congenital syndromes (i.e., CHARGE syndrome, congenital rubella syndrome, etc.). Therefore, there is no consensus regarding definition, making comparison of studies quite difficult (Larsen and Damen 2014).

Within the definition of DB, there are individuals who are congenitally DB (CDB) and those who have acquired DB (ADB). Those who are CDB are individuals who are either born with both vision and hearing loss or become deaf and blind early in their lives, before the development of language. ADB is a condition that describes individuals who become deaf and blind after they have developed language (Dammeyer 2014; Miles 2008). It is important to note that much research focused on DB does not address these two groups of individuals together but rather in isolation of each other because their developmental characteristics of language and communication are vastly different. Individuals who are classified CDB must meet developmental milestones without the use of the senses of hearing and sight, whereas those with ADB have to *maintain* the skills of language and communication which were developed before losing their senses (Dammeyer 2014). With the inconsistencies in identification as well as reporting of DB, there is wide inconsistency in prevalence data.

The smallest and most heterogeneous disability group is DB (Ferrell et al. 2014). Similar to all learners, children with DB are diverse by race, ethnicity, culture, family, community characteristics, and socioeconomic status. They also differ in degree of hearing and vision loss, age of onset, physical and health issues, cognitive functioning, communicative forms, and educational histories (Ferrell et al. 2014). The number of individuals with DB in the USA is difficult to determine due to varying definitions of the term. Miles (2008) indicated that, with the difficulty in classifying children (aged birth to 22 years) as DB, it was estimated that there were over 10,000 children in the USA. Moreover, it has been estimated that the adult deafblind population numbers 35,000–40,000 (Watson and Taff-Watson 1993).

The National Child Count of Children and Youth who are Deaf-Blind is the longest running registry of children who are DB in the world. The National Consortium on Deaf-Blindness (NCDB) conducted its census and released its most up-to-date count in October, 2015. The census collects data regarding children who not only have DB but also those with additional disabilities, noting that nearly 90% of the children included in the count have additional disabilities (NCDB 2015). The number of infants, children, and young adults who were identified as DB was 9384. This indicates a slight decrease from the 2013 census (NCDB 2015). A significant difference existed between the NCDB numbers and the population of children with DB reported by the Office of Special Education Programs, which identified 1539 children (aged 3–21). The project directors for State/Multi-State Deaf-Blind Projects explained the difference by specifying that most organizations report their children/students with DB as having other disabilities (i.e., developmentally delayed, multiply disabled, visually impaired, or hearing impaired) instead of identifying them as DB (NCDB 2015). Additionally, if a child's vision and hearing loss are not identified, they may be inappropriately labeled with ASD, attention deficit/hyperactivity disorder, intellectually disabled, or even disobedient, due to

perceptions of their behavior (Holte et al. 2006). Many concerns about the underidentification and misunderstanding of DB have often resulted in a lack or delay of appropriate intervention and/or educational placement (Malloy and Killoran 2007; Mueller 2006).

Definition and Prevalence of ASD

ASD is a neurodevelopmental disorder that is generally defined by difficulties in communication, social interaction, and insistence on sameness and routine. *The Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition* (DSM-5) established diagnostic criteria for ASD. In order to determine educational eligibility, professionals use the definition provided by the IDEIA (2004). With the specifications of the DSM-5, diagnosis and prevalence data is easier to obtain for individuals with ASD than for those with DB.

According to the Centers for Disease Control and Prevention's (CDC) Autism and Developmental Disabilities Monitoring Network, about 1 in 68 children has been identified with ASD and is 5 times more common among boys than girls (CDC 2014). The prevalence of ASD is growing and more people are being diagnosed with ASD than ever before. While it is unclear whether this increase is due to the increased endeavors in diagnosis coupled with a broader definition of ASD or if there is a true increase in the disorder, there is a likelihood that the increase is due to a combination of all three factors (CDC 2015).

Genetic Syndromes Associated with Both DB and ASD

Some genetic syndromes have been linked to both DB and ASD (see Table 1 for the primary syndromes). The two most often identified with the comorbid disorders are CHARGE syndrome and congenital rubella syndrome (CRS). CHARGE syndrome affects the body in several areas. CHARGE is an acronym standing for coloboma, heart defect, atresia choanal (also known as choanal atresia), retarded growth and development, genital abnormality, and ear abnormality (CHARGE 2016). There have been several studies regarding CHARGE syndrome and the behaviors which mimic ASD (Bernstein and Denno 2005; Fernell et al. 1999; Hartshorne et al. 2005). Using the Autism Behavior Checklist (ABC; Krug et al. 1993), Hartshorne et al. (2005) reported that 27% (out of a sample of 160 individuals) with CHARGE could be categorized as having ASD. The Centers for Disease Control (2014) states that the most

> common congenital defects of CRS include cataracts, congenital heart disease, hearing impairment, and developmental delay. Infants with CRS usually present with more than one sign or symptom consistent with congenital rubella infection. However, infants may present with a single defect. Hearing impairment is the most common single defect (para., 1).

Studies have shown that individuals with CRS also display behavior similar to ASD (4–7%; Hwang and Chen 2010; Muhle et al. 2004; Trottier et al. 1999), and for many years, it has been the primary cause of CDB (Parving and Hauch 1994).

Overlapping Characteristics of DB and ASD

The characteristics of DB and ASD may look similar because both disorders impact the way sensory information is accessed and processed (Belote and Maier 2014). Many individuals who are DB experience disorders of the eye and ear combined with visual and auditory processing problems. Those with ASD often struggle with processing visual and auditory stimulation; however, these struggles are due to how the brain processes sensory information rather than sensory loss (Belote and Maier 2014). According to Dammeyer (2014), there are three essential behavioral domains where similarities have been reported: social interaction, communication, and restricted and repetitive behavior. Moreover, Belote and Maier (2014) indicate that individuals with both ASD and DB display stereotypic behaviors, unusual responses to sensory experiences, and resistance to environmental and daily routine changes.

Social Interaction Delays in social interaction in individuals with ASD are evidenced by struggles with communicative exchanges and conversations, turn-taking, making and maintaining positive relationships and friendships, responding to and using appropriate social behaviors, and understanding jokes and figurative language (Belote and Maier 2014). Similarly, individuals with DB often display a withdrawal from and/or lack of social interaction skills due to the privation of visual and auditory access to incidental learning that would provide information which would build these skills (Belote and Maier 2014; Dammeyer 2014; Fellinger et al. 2009). Additionally, it is difficult for these individuals to establish friendships if tactile communication techniques are not used when necessary (Dammeyer 2014).

Communication Both DB and ASD result in delays or lack of verbal and nonverbal communication. Individuals with ASD exhibit reduced initiation of expressive communication, repetitive vocalizations/sounds, lack of or hindered response to others' communicative attempts, inability to maintain eye contact, inability to read nonverbal communication, and intensified attention to objects rather than individuals (Belote and Maier 2014). Another communicative feature individuals with ASD display is echolalia (repeating words and/or phrases spoken by others). When an individual is DB, their access to language and communication is greatly delayed, resulting in a severe or total absence of language (Dammeyer 2014). Furthermore, individuals with DB often display difficulties in social and

Table 1 Primary syndromes associated with deafblindness

Syndrome	Visual and auditory impairments possibly present	Outcomes
Down syndrome	Eye abnormalities (Brushfield spots, eye shape slanted, extra skin folds at inner corners of eye, inflammation of eyelids), visual acuity (nearsightedness or far-sightedness), strabismus (eyes crossing), Keratoconus (cone-shaped cornea), cataracts. Hearing loss may be present.	Vision and hearing impairments may remain present throughout life.
CHARGE syndrome	Coloboma in one or both eyes and microphthalmia. Other abnormalities that can be seen: optic nerve hypoplasia (underdeveloped optic nerve), cataracts, retinal detachment, nystagmus, and disorders of refraction and ocular movement. Typically, individuals have middle and inner ear abnormalities and unusually shaped ears with mild to profound hearing loss (CHARGE Syndrome 2016).	Vision and hearing loss remain throughout life. Research indicates behaviors similar to ASD.
Congenital rubella syndrome	Cataracts and sensorineural hearing loss in one or both ears (Heller et al. 1994).	Further conditions may develop such as glaucoma, retinal detachment, and cataracts. Some research suggests association with ASD.
Goldenhar syndrome	Defects in the eyes and ears such as cysts on the eyes, crossed eyes, missing eyelids, small ears, missing ears, ear tags, or even hearing loss (Goldenhar Syndrome 2016)	Vision and hearing loss remain throughout life.
Oculo-auriculo-vertebral spectrum (OAV)	Abnormalities of the cheekbones, jaws, mouth (including cleft lip or cleft palate), ears, eyes, and/or bones of the spinal column (vertebrae). External ear may be smaller or absent, hearing loss may be present, cysts of the eye, or colobomas (a hole in one of the eye structures, i.e., iris, retina, choroid or optic disc).	Vision and hearing loss remain throughout life.
Moebius syndrome	Eye contact difficulty, and their eyes may not look in the same direction (strabismus), eyelids may not close completely when blinking or sleeping. Hearing loss is possible (Moebius Syndrome 2016).	Some research studies have suggested that these individuals have characteristics of ASD; however, recent studies challenged this association.
Stickler syndrome	Severe nearsightedness, increased pressure within the eye (glaucoma), clouding of the lens of the eyes (cataracts), and tearing of the lining of the eye (retinal detachment), and in some, the clear gel that fills the eyeball (the vitreous) has an abnormal appearance. These eye abnormalities can cause impaired vision or blindness in some cases. Degree of hearing loss varies and could become progressively worse over time (Stickler Syndrome 2016).	Vision and hearing impairments remain present throughout life, possibly becoming progressively worse.
Usher syndrome	Retinitis pigmentosa (RP; abnormality of the cones and rods in the eyes). There are 3 types: type 1: profound bilateral deafness from birth and decreased night vision before age 10. Type 2: moderate to severe hearing loss from birth, decreased night vision, beginning in late childhood or teens. Type 3: progressive hearing loss in childhood/early teens. Vision loss severity varies with night vision loss beginning in late teens (Heller et al. 1994).	Vision loss typically begins during adolescence or early adulthood, beginning with night blindness which progresses to tunnel vision. Blindness may not occur until late adulthood.
Waardenburg syndrome	Primary sign of type 1 is increased distance between eyes, but normal visual acuity. Abnormal iris coloration, drooping eyelids, and cataracts may be present and negatively impact vision. Often, sensorineural deafness ranging in severity is present and hearing loss may be progressive (Heller et al. 1994).	Vision and hearing loss remain throughout life. Research indicates behaviors similar to ASD.

nonverbal communication due to a lack of visual and auditory access to necessary information, relying on touch as they are withdrawn and "in their own little world" (Belote and Maier 2014; Dammeyer 2014; Fellinger et al. 2009; Hoevenaars-van den Boom et al. 2009). Individuals with DB also may engage in echolalia due to the limited experiences they may have with the subject matter (Belote and Maier 2014).

Restricted and Repetitive Behavior/Stereotypic Behavior Often, individuals with ASD present behaviors such as flapping, spinning, and/or rocking as well as moving their fingers in front of their eyes. This behavior is similar to the atypical or stereotypic behaviors shown by individuals with DB (Belote and Maier 2014; Dammeyer 2014; Hoevenaars-van den Boom et al. 2009). Many of the aforementioned behaviors provide individuals with self-

stimulatory, proprioceptive input which they use to self-regulate or reduce stress levels (Belote and Maier 2014).

Responses to Sensory Experiences Unusual responses to sensory encounters are experienced by individuals with ASD as well as those with DB. Individuals with ASD often struggle with either reduced or intensified responses to loud or quiet sounds, textures, lights, reflective objects, pressure, temperatures, or pain (Belote and Maier 2014). When an individual has DB, they often display tactile defensiveness or an antipathy toward specific textures and experiences due to an absence of consistent information about the world around them or a result of neurological issues (Belote and Maier 2014).

Environmental and Daily Routine Changes Environmental and/or daily routine changes may be quite disturbing for individuals who have ASD or DB. Frequently, individuals with ASD insist that certain objects be organized in a specific way and prefer rigid, consistent routines and schedules. When these things are changed, they experience great distress (Belote and Maier 2014). For individuals with DB, it is important to maintain a sense of order, a clearly structured environment, prime lighting and contrast, reduction of noise, and appropriate introduction of new situations (i.e., tactile or reference objects; Fellinger et al. 2009). With a loss of vision, environmental stability is vital for orientation and mobility. With the loss of sensory information, routines are very important in order to allow these individuals to sustain control over their world which may seem confusing; they depend upon predictability and schedules for comprehension (Belote and Maier 2014).

Educational Placement

For educational purposes, an individual is considered to be DB when the amalgamation of the loss of hearing and sight produces such severe communication and developmental delays that their educational needs require substantial distinctive adaptations and modifications to their educational program (Larsen and Damen 2014). While an educational diagnosis of DB is possible, children are often identified with a primary label that is not DB. The NCDB 2014 National Child Count (2015) cites that only 17% of children aged 6–22 fell under the IDEA Part B category of DB and that the majority of students (35%) were reported in the primary disability category of multiple disabilities (see Fig. 1 for all reported categories). Because of the wide variability of primary disability labels and the lack of educational personnel who are trained in DB, these students are often served by the teacher who has a license which corresponds to the child's primary education label (see IDEA, Part B) (NCDB 2015). These may be teachers of the deaf and hard of hearing (TODs), teachers licensed in low vision and blindness (TVIs), and/or teachers with a certificate in general special education. If children who are DB are to be appropriately served and receive services which meet their unique needs, there is a greater need for interventionists and teachers who have the knowledge of DB instruction and intervention, individualized supports, and intervener services (NCDB 2014).

The Individuals with Disabilities Education Improvement Act (IDEIA) of 2004 instituted the requirement that education teams select the least restrictive environment (LRE) when determining educational placement. When considering educational placement, it is imperative that opportunities for active participation in the general education program as well as social interactions within the classroom be provided. Due to the high heterogeneity of this population of learners, a variety of placements is necessary to address their diverse needs (Ferrell et al. 2014). Students who are DB receive education services in general education classrooms, separate schools, residential facilities, homebound hospitals, and private schools (see Figs. 2, 3, and 4; NCDB 2015). There are only nine university

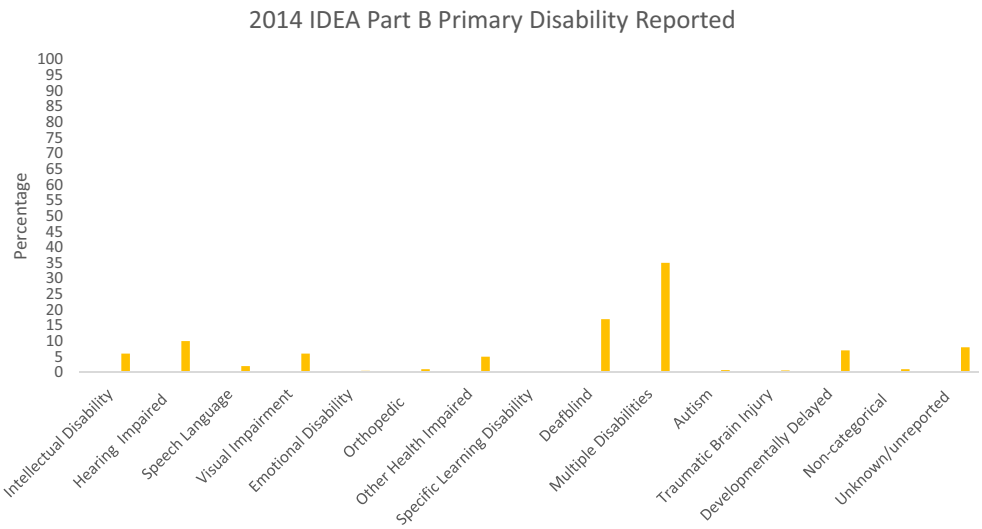

Fig. 1 Primary disability labels given to students who are DB during the 2014–2015 school year

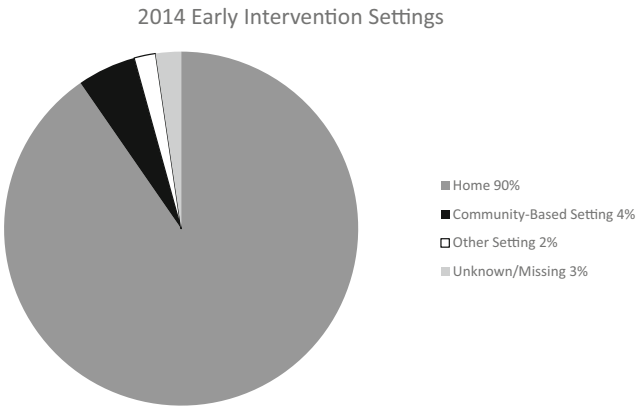

Fig. 2 Educational placements for students with DB served in early intervention during the 2014–2015 school year

teacher preparation programs which offer coursework in DB (Hall 2003) and only two states in the USA which offer a teaching endorsement in DB (Illinois and Utah; A. Parker, personal communication, November 2, 2015). With so few teacher preparation programs as well as the limited states providing teacher certification in DB, there exists a great need for teachers in this area (Zambone and Huebner 1993; McLetchie and MacFarland 1995).

There is also great variability of educational placement for students with ASD in the USA. Education teams work together to make placement decisions based on a number of different factors for each child with the mandate of placing each child in the LRE as described by IDEIA (2004). The child's educational needs are of utmost importance when placement decisions are made, not convenience. Similar to placement options for students with DB, a continuum of educational placements for students with ASD is available such as general education classroom with special education consult support, partial general education classroom and partial special education classroom, full-time special education classroom, separate specialized school, or specialized instruction in the home or a hospital, if necessary. Given the even lower incidence of DB and ASD as comorbid diagnoses, there is no data available on current educational placements for this particular population. All placement options would be available through legislative precedence and would likely fall into the same categories mentioned above for each distinct disability.

Interventions from the Field of DB

Research in the area of DB is limited due to the rarity of the disorder, highly heterogeneous population, and finite number of trained practitioners. It is initially important for us to present the difficulty in discussing educational practices, interventions, and EBPs based on terminology alone. We will discuss educational practices and interventions as those that are not yet proven to be EBPs through the rigorous scientific standards and will use those two terms interchangeably. A further discussion of EBPs identified in both the DB and ASD fields follows below. There is one review of practices for increasing effective communication strategies for children with comorbid VI and additional disabilities which includes strategies used in the field of DB. Most of the literature focuses on increasing communication because, without a dependable means of conveying and acquiring information, children with multiple disabilities are at jeopardy not only for developing their educational potential, but also for suffering abuse and neglect (Knutson and Sullivan 1993). Additionally, supporting the communication of children with comorbid VI and additional disabilities must focus on recognizing and responding to many different forms of communication, especially nontraditional methods of communication such as movements and facial expressions (Parker et al. 2008) in order to develop a consistent, practical communication method for them (Bruce 2005a). Parker et al. (2008) identified 30 studies with a number of diverse types of interventions, noting that microswitch interventions have a long-standing research

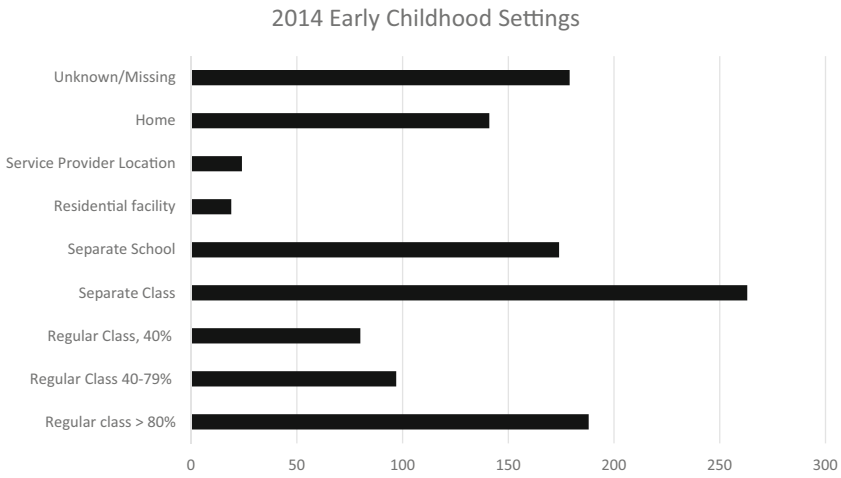

Fig. 3 Educational placements for students with DB served in early childhood settings during the 2014–2015 school year

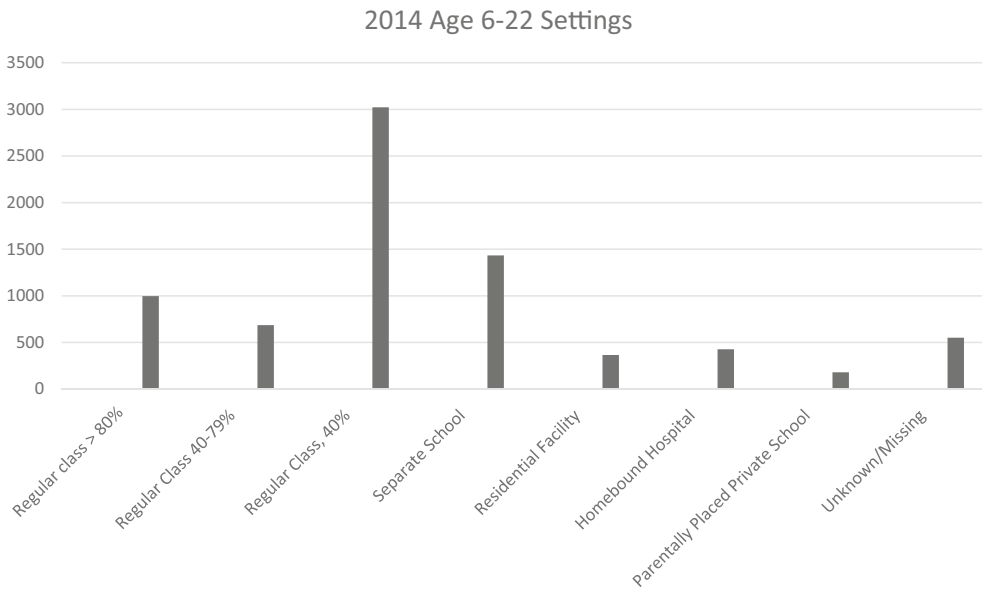

Fig. 4 Educational placements for students with DB served in school-aged settings during the 2014–2015 school year

base, and multicomponent interventions (involving the preparation of and support from partners) and dual communication boards were considered "probably effacious" (Parker et al. 2008).

Distancing According to Bruce (2005a), the development of communication includes the comprehension of symbols. Children who are DB display a delay in distancing themselves from others. In order to develop distance from others, one must understand that he or she is a separate individual. However, children who are DB often view themselves as an extension of others. Children without sensory loss use visual observation of others to develop their understanding of self, object permanence, joint attention, as well as many other important skills (Bulman 2006). The distancing technique is a progressive procedure which includes separating oneself from others, both physically and psychologically (understanding they are a separate individual), from objects (share joint attention with another in order to think about the differences and similarities between different objects), and the separation of object and representation (reenacting movement as well as incorporating an object in the reenactment). When a child has DB, they are deprived of the support provided through vision and hearing for recognition of different milieus, creating a need for these individuals to experience far more than those without sensory loss in order to develop their understanding of the pairing of the referent object and its representation. To facilitate distancing for children with DB, it was suggested to use strategies such as hand-under-hand exploration (with the child's hand on top of the adult's hand) in order to perceive the entirety of an object, select cues for recall based on the child's most significant observation of an object so as to promote memory and understanding of that object, and provide models of play that are just above the child's current level of play (Bruce 2005b).

Tangible Symbols Rowland and Schweigert (1989) describe tangible symbols as two-dimensional (photographs or line drawings) or three-dimensional (whole or partial objects) which are used to communicate by individuals with DB who are at the prelinguistic level of communication. Many different researchers have conducted studies to demonstrate the effectiveness of this intervention (Bruce and Borders 2015). Other tactile interventions (tangible cues, learning through touch, tactile sign, object cues) used in the field of DB have been used to stimulate the development of communication. An explanation of each follows:

- Tangible cues are tangible symbols that are used to support receptive communication (Bruce and Borders 2015).
- Learning through touch describes how the hands function as eyes for learners with DB (Miles 2003).
- Tactile sign is accomplished by having the person with DB hold the communication partners wrists, feeling their movements as they sign (Hersh 2013).
- An object cue is an object or part of an object that is used to support language development and social interactions of individuals with DB (Trief et al. 2009).

The field of DB is challenged by a low number of researchers with positions that often are not research intensive. Limited time for researcher coupled with a heterogeneous and widespread subject population makes the establishment of EBP in the field quite difficult. On the contrary, scientific establishment of EBPs in the field of ASD has been established based on over 50 years of research.

EBPs in the Field of DB

According to Ferrell et al. (2014), there are five practices used in the field of DB for communication intervention which qualify at the limited or moderate level of EBP. These consist of child-guided approaches (limited), systematic instructional approaches (moderate), adult communication partner interaction behavior interventions (limited), tangible symbols (moderate), and tactile interventions (moderate; Bruce and Borders 2015). Table 2 defines each of these practices.

EBPs in the Field of ASD

According to The National Professional Development Center on Autism Spectrum Disorder (NPDC), 27 EBPs have been identified for use with individuals with ASD (see Table 3). In 2014, the NPDC used rigorous standards to identify focused interventions as EBPs. When implemented with fidelity with students with ASD, these interventions have been shown through scientific research to be effective. In order for an intervention to be deemed an EBP, it was required to meet the following criteria:

- Randomized or quasi-experimental design studies. Two high-quality experimental or quasi-experimental group design studies conducted by at least two different researchers or research groups, OR
- Single-subject design studies. Five high-quality single-subject design studies conducted by three different investigators or research groups and having a total of at least 20 participants across studies, OR
- Combination of evidence. One high-quality randomized or quasi-experimental group design study and at least three high-quality single-subject design studies conducted by at least three different investigators or research groups (across the group and single-subject design studies). (NPDC 2014, pp. 15–16).

NPDC continually reviews literature, adding EBPs as they meet the above criteria.

The presence of overlapping symptomology between DB and ASD in addition to difficulties associated with the limited number of interventions and EBPs for use with students who are DB leads to a perplexing issue for teachers and professionals. The purpose of this literature review was to identify potential educational practices or EBPs for students with comorbid DB and ASD. Further, the concept of differential diagnosis was also searched to offer guidance from research that could lead educators in service provision.

Method

Initial key word searches were conducted to elicit all articles with relevant content related to DB, ASD, interventions/EBPs, and differential diagnosis. Boolean operators *and* and *or* were used to look for articles that included all or any of the identified key words across five databases (PsychInfo, PubMed, MedLine, Academic Search Complete, and ComDisDome). Additionally, the National Center on Deafblindness's (NCDB) Information Specialist assisted in conducting a specialized search. The information obtained from NCDB verified the dearth of available literature, but yielded an additional five articles. No previous literature reviews investigating interventions or EBPs for children with comorbid ASD and DB were located.

The combined terms of *deafblind** AND *autism*, *pervasive developmental disorders*, OR *autistic*, AND *evidence-based practices* OR *interventions* OR *diagnosis OR differential diagnosis* yielded the results found in Fig. 5. Additional search terms included *characteristics*, *assessment*, *language*, *communication*, and *social*. Literature that included the combined search terms were included and then examined for additional inclusionary criteria: (a) studies published in English and (b) in peer-reviewed journals, (c) were empirical, and (d) were educational interventions. Results were further limited to (e) the past 20 years. Articles were excluded if they (a) were dissertations, (b) did not mention intervention practices, (c) were not empirical, or (d) included only medical intervention. An additional hand search was conducted on reference lists from found articles to ensure a comprehensive review.

Results

Figure 5 illustrates the search process for this literature review. Twenty-five articles were identified using this search strategy from an extensive assortment of search engines and related periodicals and websites. Due to the low number of available articles, snowball sampling was also used and yielded an additional 11 articles for review. Once the articles were reviewed for inclusionary criteria and duplicates were removed, 15 articles were designated as meeting criteria, provoking reading of the full articles. These articles were included in the review with a summary of each found in Table 2. The only findings reported in this literature review are those which address interventions/EBPs or differential diagnosis for students with comorbid DB and ASD.

Differential Diagnosis

Five articles were identified that discussed differential diagnosis between DB and comorbid DB and ASD. Differing views regarding the need for or accuracy of such diagnosis were

Table 2 Summary of reviewed articles

Author(s)	Participant(s)	IV	DV	Psychometric information	Findings
DB approaches					
Brady and Bashinski (2008)	9 children aged 3–7 with DB and multiple disabilities (USA)	Adapted version of Prelinguistic Milieu Teaching (A-PMT)	Children's communicative intents	Interrater reliability between two separate coders was calculated using videotaped intervention sessions (one per week per participant across the entirety of the study). Mean scores were .803 (type of communication), .801 (communicative function), and .721 (form of communication).	All participants showed varying degrees of increase in communication intentions (communicative diversity forms and functions and independent communication). Targeting prelinguistic behaviors may be a valuable addition to communication programs for children with similar needs to the participants
Heller et al. (1994)	3 high school students who were DB enrolled at a vocational-based training program (USA)	Dual communication boards	Social communication responses (expressive and receptive)	Interrater reliability was conducted for 32% of the sessions for each student. Agreement checks resulted in 98.8% agreement.	The use of dual communication boards helped improve social communication responses. Using dual communication boards appeared to have clarified communicative intent or function of partner and may have served as an indicator of completed communication exchange.
Janssen et al. (2002)	4 children, aged 6–9 years, with DB and with educators (Dutch Institute for the Deaf)	Educator training program	Educator response to child interactive behaviors	Each session was observed by 2 observers. Reliability was computed for educator responses (30% of the sessions) and child interactive behaviors (50% of the sessions). Interobserver agreement ranged from 82.9% to 100% across situations with a mean agreement of 92.2% (child behaviors) and 92.5% (educator responses).	Results indicated that it is possible to improve interaction of children with DB by teaching their educators how to more appropriately respond to interactive behaviors. An increase in interactive behaviors led to a decrease in aberrant behaviors.
Janssen et al. (2002)	6 children with DB, 14 educators (Netherlands)	Educator training program "Contac," an adaptation of 2002 program	Educator response to child interactive behaviors	Psychometric information (reliability, validity, and/or fidelity) was not reported for this intervention.	Results indicated that the program improved the quality of daily interactions between educators and students. Coaches helped educators recognize interaction signals and attune to their behaviors.
Janssen et al. (2004)	16 educators and 4 children with DB, aged 7–11 (Dutch Institute for the Deaf)	Educator training program (replication of the 2002 study)	Educator response to child interactive and	A study-specific observation form was used to score videos by 2 independent raters. Prior to data collection, observers were trained	Findings were similar to the 2002 findings in that the intervention increased interactive behaviors while decreasing aberrant

Table 2 (continued)

Author(s)	Participant(s)	IV	DV	Psychometric information	Findings
			independent behaviors	for all target behaviors (3 sessions per child) until 80% agreement was reached. To control for observer drift and bias, observers did not know the hypothesis; prior to sessions, observers read the response definitions; and no feedback was given relative to reliability for their scoring. IOA was computed for 30% of the sessions and ranged from 73 to 100%. Means were as follows: 87.3% (appropriate child interactive behaviors); 91.3% (independent child behaviors); 93.5% (inappropriate child behaviors); 86.9% (adequate educator response); and 97.4% (inadequate educator response). Social validity scales evaluated educator and parent satisfaction as well.	behaviors. Researchers also evaluated the lasting effects of the intervention, finding that when educators continued responding at a high level, student interactive behaviors remained high, but when educator responding decreased, so did the students' interactive behaviors.
Janssen et al. (2006)	1 student (DB) and his educator (Netherlands)	Diagnostic Intervention Model	Active involvement of student during calendar and dressing and feelings of well-being	Five-minute sections of interactions were videotaped and used to assess the frequency and duration of target behaviors. The first author and two research assistants were trained to 80% IOA for all categories except affective involvement. IOA was obtained for 25% of the videotaped interactions with a mean score of 92.6% across all categories assessed. Social validity of the intervention was assessed by teacher response using a 5-point Likert scale.	A detailed description of how to use the Diagnostic Intervention Model was shown through the case study. Positive effects of the intervention were obtained and maintained for all but one target behavior (feelings of well-being).
Martens et al. (2014)	Four participants with CDB and 16 communication partners (Royal Dutch Ketalis)	Intervention Model for Affective Involvement (IMAI)	Participant affective involvement, positive and negative emotions	Psychometric information (reliability, validity, and/or fidelity) was not reported for this intervention.	Three participants showed an increase in affective involvement with all 4 participants displaying an increase in positive emotions with a decrease in negative emotions; however, the intervention was difficult to maintain over time. Authors

Table 2 (continued)

Author(s)	Participant(s)	IV	DV	Psychometric information	Findings
					recommended permanent coaching for communication partners.
ASD EBPs					
Bracken and Rohrer (2014)	3 DB individuals with ID, aged 30–39 (Ireland)	PECS	Participant communication attempts	IOA was collected for 30% of all sessions in all phases and resulted in 90–100% agreement across all phases and participants. Additionally, baseline collection was staggered by 1 day per participant and 3 or more baseline points were obtained to control for threats to internal validity.	PECS training shown to be useful in increasing communication for adults with DB and ID
Johnson and Parker (2013)	3 children with VI, DD, and communication delay (USA)	Wait time	Child intention communication attempts	Social validity was assessed for both participants and their families via interview.	All 3 children increased intentional communication. Each participant's families continued to use the intervention to generalize skills and increase communication. Utilizing wait time procedures proved to be very successful.
Taylor and Preece (2010)	3 students with MD and VI (England)	TEACCH	Student behavior, transitions, independent work skills	Psychometric information (reliability, validity, and/or fidelity) was not reported for this intervention.	Using TEACCH in the classroom clarified expectations for the students, minimized confusion and anxiety, supported transition, minimized aberrant behaviors, and increased independent working.
Differential diagnosis					
Belote and Maier (2014)	–	–	–	Psychometric information (reliability, validity, and/or fidelity) was not reported for this intervention.	The possibility exists for children to have comorbid DB and ASD; however, it is more likely that a child who is DB simply appears to have similar behavioral features to ASD. Outline similarities between DB and ASD.
Dammeyer (2014)	71 children with CDB (Aalborg, Denmark)	Autism Behavior Checklist	Symptoms of ASD	Psychometric information (reliability, validity, and/or fidelity) was not reported for this intervention.	Examined symptoms of autism and found that all children displayed symptoms of autism on a level similar to children with another developmental disorder other than autism (i.e., intellectual disability). No association found

Table 2 (continued)

Author(s)	Participant(s)	IV	DV	Psychometric information	Findings
					between the severity of sensory impairment and severity of symptoms of autism.
Fellinger et al. (2009)	253 individuals with intellectual disability (Institute Harbeim, Upper Austria)	Survey	Identification of sensory impairments	Otoacoustic emissions (OAE) screening was used to assess hearing. To ensure reliability, each participant was first evaluated by an ear, nose, and throat specialist, and behavioral audiometry was administered by a skilled audiologist for any participant who had an abnormal OAE or for those for whom an OAE screening was not practical. Three orthoptists skilled in working with individuals with severe multiple disabilities assessed vision. To ensure reliable outcomes, two orthoptists worked in tandem and agreed upon the results.	Information obtained exposed a wide variance in identification of DB in participants before and after screenings were conducted. Before in-depth screenings, 12.5% of the subjects were diagnosed with HI, 17% with VI, and 3.6% with DB. After screenings, diagnoses revealed 46% with HI, 38.4% with VI, and 21.4% with DB. Recommendations for identification as well as interventions provided.
Hoevenaars-van den Boom et al. (2009)	10 people with CDB and ID, 5 with ASDD, and 5 without (Netherlands)	Observation of Autism in Persons with Deafblindness (O-ADB)	Ability to differentiate characteristics of DB and ASD	Psychometric information (reliability, validity, and/or fidelity) was not reported for this intervention.	Authors developed the instrument in an attempt to differentiate characteristics of DB from ASD in people with CDB and ID. Results were variable and a consensus could not easily be reached; however, the authors contend it is possible to differentiate using this assessment.
Johansson et al. (2010)	Individuals with Möbius, CHARGE, and oculo-auriculo--vertebral syndromes (Sweden)	Autism Diagnostic Interview-Revised (ADI-R), the Childhood Autism Rating Scale (CARS), and the Autistic Behavior Checklist (ABC)	Applicability of ASD diagnostic instruments	Psychometric information (reliability, validity, and/or fidelity) was not reported for this intervention.	Results indicated that, in order to diagnose ASD in these individuals, it is critical to use an extensive sequence of diagnostic instruments in conjunction with autonomous opinions from at least 2 clinicians. Moreover, the current ASD diagnostic instruments produce highly questionable results for individuals who are DB.

Table 3 EBPs in the field of ASD

EBP	Definition
Antecedent-based intervention (ABI)	Used after an FBA has been conducted to address interfering and on-task behaviors. The goal is to identify factors that reinforce the behavior then modify the environment. Common procedures: use highly preferred activities/items to increase interest, change of schedule/routine, implementation of preactivity interventions, offering choices, changing teaching method, and enrichment of environment to allow learners access to sensory stimuli serving the same function of the behavior (Neitzel 2009a).
Cognitive behavioral intervention (CBI)	CBI focuses on teaching learners to regulate their emotions in order to reduce meltdowns, challenging behaviors, interruptions, or angry outbursts. The goal is to stabilize emotions and improve behavior (Brock 2013).
Differential reinforcement of alternative, incompatible or other behavior (DRA/I/O)	Reinforcement is provided for desired behaviors while ignoring inappropriate behaviors. Designed to reduce the occurrence of interfering behaviors. By reinforcing more functional behaviors or behaviors that are incompatible with the inappropriate behavior, the aberrant behavior will likely decrease (Bogin and Sullivan 2009).
Discrete trial teaching (DTT)	A one-to-one instructional approach used to teach skills in a systematic manner. The use of antecedents and consequences is carefully planned, skills and behaviors are reinforced with either tangible and/or positive praise, and data collection is imperative. Data is used to support decision-making (Bogin 2008).
Exercise (ECE)	Can be used with learners to improve physical fitness as well as increase desired behaviors and decrease inappropriate behaviors (AFIRM 2015a).
Extinction	Based on applied behavior analysis to reduce/eliminate undesired behaviors. Withdrawal or termination of positive reinforcer which maintains the behavior. Differential reinforcement is often used to increase appropriate behaviors while discouraging the aberrant behavior (Sullivan and Bogin 2010).
Functional behavior assessment (FBA)	Systematic set of strategies used to identify the underlying function/purpose of a behavior in order to develop an intervention plan. The problem behavior is identified as well as the antecedent and consequent events which control the behavior before a hypothesis is developed and then tested (Collette-Klingenberg 2008a).
Functional communication training ((FCT)	A systematic practice used to replace aberrant behavior or communicative acts with more appropriate communicative behaviors/skills. FCT is always executed after an FBA has been conducted to identify the function of the behavior. The teacher analyzes the behavior to identify what the learner is attempting to communicate and then use FCT to teach a replacement behavior which is simple to use and serves the same purpose as the interfering behavior (Franzone 2009a).
Modeling (MD)	Live modeling a demonstration by an individual of the target behavior in the presence of the student with ASD. Video modeling is a prerecorded movie of an individual demonstrating the target behavior (NAC 2011).
Naturalistic intervention (NI)	An assortment of practices including environmental arrangement, interaction techniques, and strategies based on applied behavior analysis. Based on learner interests, NI is used to encourage specific target behaviors by building more naturally reinforcing, appropriate, complex skills (Franzone 2009b).

Table 3 (continued)

EBP	Definition
Parent-implemented intervention (PII)	Parents implement individualized intervention strategies with their child to increase positive learning opportunities and achievement of essential skills. Through a structured parent training program, parents learn to implement strategies in their home and/or the community (Hendricks 2009).
Peer-mediated intervention and instruction (PMII)	Peers without disabilities are systematically taught ways to engage students with disabilities in positive and meaningful social interactions (AFIRM 2015b).
Picture Exchange Communication System (PECS)	Designed to teach children to communicate in a social context. Learners using PECS are taught to give a picture of a desired item to a communication partner in exchange for the item. There are 6 phases, each one building upon the previous step, from teaching the physically assisted exchange to commenting in response to a question (Collette-Klingenberg 2008b).
Pivotal response training (PRT)	Intervention focuses on augmenting 4 essential learning variables: motivation, responding to multiple cues, self-management, and self-initiations. PRT builds on learner initiative and interests and is principally effective for increasing communication, play, and social behaviors (Vismara and Bogin 2009).
Prompting (PP)	Specific skills relative to behavior are targeted in order to increase success and generalizability. A prompt is a cue meant to encourage a desired behavior (AFIRM 2015c).
Reinforcement (R+)	R+ is used in conjunction with other EBPs. Reinforcers are used to increase the likelihood that a learner will perform a specific skill or behavior in the future (AFIRM 2015d).
Response interruption/redirection	Used to decrease interfering behaviors (usually those which are repetitive, stereotypical, and/or self-injurious). Implemented after an FBA has identified the function of the behavior. The interventionist interrupts the learner from engaging in the interfering behavior and redirect them to a more appropriate behavior (Neitzel 2009b).
Scripting	Helps learners anticipate what may occur in order to encourage appropriate behavior and participation by presenting a verbal and/or written description of the skill/situation. The description is practiced repeatedly beforehand (Fleury 2013).
Self-management	Learners are taught to distinguish between appropriate and inappropriate behaviors, accurately monitor and record their own behaviors, and reward themselves for appropriate behavior (Neitzel and Busick 2009).
Social narratives	Used to describe social situations and explain feelings and thoughts of others, suitable behavior expectations and applicable cues to the learners (AFIRM 2015e).
Social skills training	Small groups of learners (2–8) with disabilities and a teacher are used to teach ways to appropriately socially interact with typically developing peers. Meetings include instruction, role playing, practice, and feedback (Collette-Klingenberg 2009a).
Structured play group	Used to address social, communication, behavior, play, school readiness, and academic skills by utilizing small groups of typically developing learners, individuals with disabilities and an adult leader. A defined area and activity are identified for each session (Odom 2013).
Task analysis	Breaking down a task into its component parts in order to teach learners individual steps of the task until they have mastered each one (Task Analysis 2015).

Table 3 (continued)

EBP	Definition
Technology-aided instruction and intervention	Electronic devices used to produce speech and/or teach academic skills and increase communication, language development, and skills. Computer modeling and tutors may be used (Collette-Klingenberg 2009b; Franzone and Collette-Klingenberg 2008a).
Time delay	Focuses on fading prompts during instruction and used in conjunction with prompting procedures. A brief delay is provided between initial instruction and instructions or prompts. Two different types are described: progressive time delay (time is gradually increased between instruction and prompts) and constant time delay (a fixed amount of time is always used) (Neitzel 2009c).
Video modeling (VM)	Mode of teaching which uses videotaped visual models of the targeted behavior/skill. There are 3 different types: basic (recording someone else performing the skill for learner to watch later), self-modeling (the learner performs the skill then watches video later), and video prompting (skill is divided into steps and recorded with pauses incorporated to encourage practice of the step by the learner) (Franzone and Collette-Klingenberg 2008b).
Visual support (VS)	Any tool presented visually which provides support for a learner during the day. VS may include pictures, words, objects, arrangement of the environment, visual boundaries, schedules, maps, labels, and scripts (Hume 2008).

present across the literature. Few researchers have attempted to differentiate between ASD and DB based on a number of reasons. One problem with diagnosis is that there is a near absence of well-validated assessments to gauge even the most basic features (i.e., intelligence) in individuals who are DB (Vernon 2010). The standardized assessments which exist are neither trustworthy nor useable with individuals with DB as they do not account for the effects of multiple disabilities (Nelson et al. 2002). Another difficulty is that one of the main symptoms of both ASD and DB is the lack of communication skills which greatly limits any communicative interaction between the individual and the assessor, resulting in a relatively ineffective evaluation (Vernon 2010). Because DB is one of the rarest and most severe disabilities both psychologically and educationally, when ASD is added, the difficulties experienced are exponentially increased (Vernon 2010). Moreover, many researchers are exceptionally cautious about the topic of the diagnosis of comorbid ASD and DB because of "autism drift" (identifying features of DB as those of ASD by individuals who are unfamiliar with DB; S. Bruce, personal communication, September 9, 2015). It is important that anyone with experience in diagnosing ASD should not pursue diagnosis of it in a child with DB without having the consultation of someone trained in DB (S. Bruce, personal communication, September 9, 2015).

Hoevenaars-van den Boom et al. (2009) indicated that identifying whether the underlying factors causing behavioral characteristics of the individuals are caused by ASD or by the sensory impairment is important. The atypical behaviors of individuals with DB may be attributed to DB, masking ASD (Smith et al. 2005); however, these same behaviors may also be easily confused with ASD. Furthermore, many individuals with DB also have ID which further confounds the diagnosis (Hoevenaars-van den Boom et al. 2009). Belote and Maier (2014) contend that, while the possibility exists that children can have comorbid DB and ASD, however, it is more likely that the two share characteristics. Their article detailed the ways in which a dual sensory loss could explain "autistic-like" features in individuals who are DB. Fellinger et al. (2009) sought to ascertain the number of individuals with ID in a residential facility who had undiagnosed DB. The participants in the study had the most severe ID, physical disabilities, behavior, and emotional difficulties, and the authors investigated the relationship between these characteristics and DB. They found that the diagnosis was often not identified by either medical testing or residential care staff and that only individuals with profound DB had the likelihood of being diagnosed.

Dammeyer (2014) and Hoevenaars-van den Boom et al. (2009) conducted studies in an effort to explore the ability to differentiate ASD symptoms from DB. Hoevenaars-van den Boom et al. (2009) developed an instrument, "Observation of Characteristics of Autism in Persons with Deafblindness" (O-ADB) for their study which contained theories found in literature based upon behaviors found in individuals with ASD and was administered by a team of experts familiar with

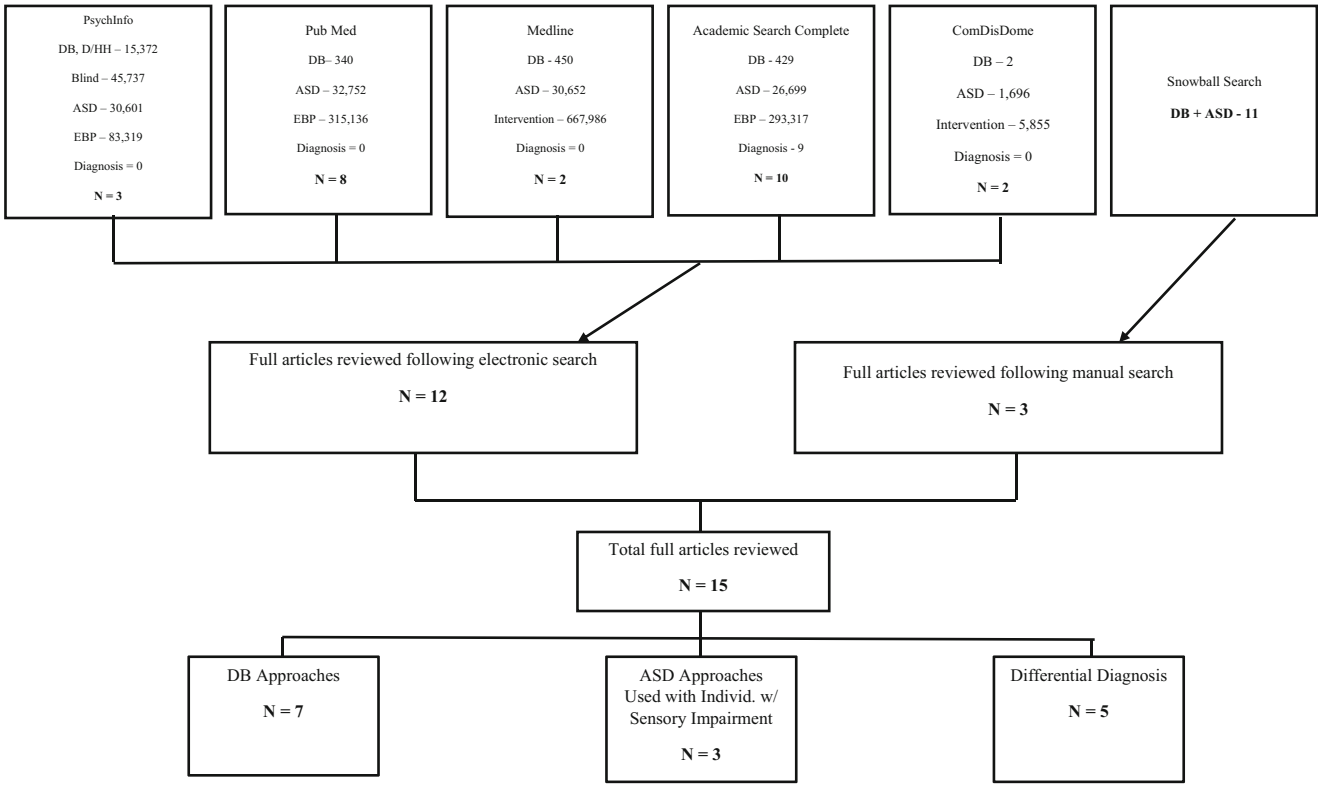

Fig. 5 Flowchart of literature search

ASD, DB, and ID. They reported that they used the Autism Screening Instrument for Educational Planning (Krug et al. 1980), Autism Diagnostic Interview—Revised (Le Couteur et al. 2003) and the Van Dijk Approach to Assessment (also referred to as "Hands-on Assessment) to develop the items and norms of O-ADB. Although the reliability of the O-ADB was low for some of the items and the team of experts who administered the assessment did not reach consensus for one third of the individuals assessed, Hoevenaars-van den Boom et al. (2009) report that this assessment seemed to be useful for differential diagnosis between the behaviors of individuals with DB and comorbid ASD and those people with DB only. Moreover, Hoevenaars-van den Boom et al. (2009) state that those with comorbid DB and ASD display significantly more behaviors that are autistic-specific than those without ASD. The differences noted by Hoevenaars-van den Boom et al. (2009) were in social interaction and communication. No differences were identified in restricted patterns of behavior, interests and activities, or in exploration, play, or problem-solving behaviors. Lastly, they state that using stereotyped behaviors as a characteristic for differential diagnosis of ASD is poor because the baseline levels of these behaviors are too high (Hoevenaars-van den Boom et al. 2009).

Dammeyer (2014) asserts that it is imperative to differentially diagnose CDB and ASD because, in order to appropriately plan educational programming and interventions, it is important to know what the social and communication delays are a result of sensory impairment or ASD. Dammeyer's (2014) study sought to discover the pervasiveness and characteristics of ASD among a group of children who had CDB in Aalborg, Denmark. By recruiting DB consultants to fill out the ABC Questionnaire to assess the social interaction, communication, and behavior of their clients with DB, Dammeyer found that children diagnosed with ASD and those with DB can be differentiated. Furthermore, he states that differential diagnoses must only be performed by individuals who are experts in both ASD and CDB and that continuous assessment of the individual's functional vision, hearing, communication, and social interaction may be useful in the diagnostic procedure (Dammeyer 2014).

Johansson et al. (2010) examined the applicability of existing ASD assessments such as the Autism Diagnostic Interview-Revised (ADI-R), the Childhood Autism Rating Scale (CARS), and the ABC with individuals who had M bius sequence, CHARGE syndrome, and oculo-auriculo-vertebral spectrum (OAV). Each of these congenital syndromes involve a variety of conditions involving multiple organs and senses (including DB) as well as behaviors which mimic ASD. Differential diagnosis using the ADI-R, CARS, and ABC presented difficulties which were amplified when more severe disabilities were present. Specifically, there was both over- and underdiagnosis of ASD in participants when the researchers used the CARS and the ABC. Additionally, the CARS overdiagnosed some individuals. Of primary

importance was the substantial discrepancy in scores for participants who were DB. The authors note that sensory deprivation can contribute to symptoms which resemble ASD and be misinterpreted, therefore complicating differential diagnosis.

Interventions or EBPs

Ten articles were reviewed that discussed interventions or EBPs used with students with DB. While none included a student with diagnosed comorbid DB and ASD, they were reviewed based on the inclusion criteria mentioned above and likely selected in databases due to the authors' mention of multiple disabilities and characteristics of ASD in their articles. Seven of the 10 articles detailed the use of an intervention from the field of DB, while three used an EBP from the field of ASD with a DB population of students.

Interventions from the DB Field

Five of the seven articles related to DB interventions specifically discussed the use of affective communication interventions with students who are DB. One discussed the use of dual communication boards and one used an adapted version of prelinguistic milieu teaching (A-PMT).

Affective Communication Interventions Affective communication is the reciprocal sharing of emotions and is crucial to the regulation of emotions and development of secure relationships (Martens et al. 2014). Affective communication interventions focus on providing instruction to communication partners regarding recognizing affective behaviors in addition to increasing responses to those behaviors. Five of the reviewed articles used affective communication interventions to increase the skills of students with DB through training communication partners.

In a series of studies, Janssen et al. (2002, 2003, 2004, 2006) used affective communication interventions to successfully increase interactive behaviors of children with DB and decrease inappropriate behaviors. The components of the intervention consisted of training educators to respond more effectively to interactive behaviors which were suitable and unsuitable, as well as teaching the educators how to adjust the type of interactions to promote appropriate behaviors and independent functioning of the children. In the 2002 study, the researchers investigated what effects an intervention program focused on educators would be on improving the quality of the exchanges between children who are DB (aged 6–9) and their educators. The educators ($n = 14$) received training to help them more effectively respond to a designated set of suitable and unsuitable interactive child behaviors. The 2004 study used the same intervention model to train 16 educators of children who were aged 7–11. The difference between the 2002 and 2004 studies was that the latter study employed less individual supervision (decreased from once every few weeks to three times total). In 2003, Janssen et al. adapted the 2002 intervention model to make it more appropriate for everyday use as well as usefulness in the home for 14 educators and six children. Videotaping and the use of coaching aided educators in their ability to recognize interaction signals of the children and attune to their behaviors. The article written in 2006 was a case study of one of the individuals included in the 2003 article in which the authors provided a more comprehensive description of the methods applied in the Diagnostic Intervention Model. General implications relative to daily practice and excellent interaction coaching were detailed as well.

Martens et al. (2014) used the Intervention Model for Affective Involvement (IMAI) to train staff members (e.g., teachers, caregivers, support workers) to nurture affective involvement during communication with individuals who have CDB. IMAI focuses on improving communication partners' abilities to recognize affective behaviors, be responsive to interactive behaviors, share meaning with the individual with CDB to improve understanding, share emotions, evaluate their own affective behavior, and adapt to improve affective involvement. Coaching is also a part of this model and provides input to the communication partners to assist them in improving their affective communication with their clients. While the participants displayed an increase in positive emotions with a decrease in negative emotions, the intervention was difficult to maintain over time. Therefore, permanent coaching was recommended.

Dual Communication Boards Assistive technology (AT) devices are considered tools to assist students with disabilities to overcome or bypass their disability to participate or achieve in academic and functional areas (Edyburn et al. 2005; Okolo 2008). AT can consist of both low tech (nonelectronic) and high tech (electronic). Heller et al. (1994) addressed the use of AT as an effective intervention for individuals with DB.

One low tech device is a dual communication board. These boards are used to expand the communication system of an individual with DB to provide a communication partner ease of interpretation (Heller et al. 1994). Dual communication boards are visually enhanced pictures (one for the student with DB and one for the partner) consisting of vocabulary specific to the environment (for example, job sites) as well as social content. Heller et al. (1994) utilized dual communication boards to teach suitable communication responses to three high school students who were DB. When assessed in three different routines (both school and community), all of the students were able to use the boards with 100% accuracy, clarifying the intent of their communication.

Adapted Prelinguistic Milieu Teaching Brady and Bashinski (2008) used A-PMT with nine children, aged 3–7 years who were DB and had multiple disabilities. A-PMT was developed by modifying the prelinguistic milieu teaching (PMT) model which combined strategies (delayed prompting, modeling, and environmental arrangement) within an extremely motivating, child-driven teaching setting (Brady and Bashinski 2008). When making adaptations to the PMT intervention, Brady and Bashinski (2008) sought to make the strategy accessible to and appropriate for children with comorbid vision and hearing loss by minimizing actions that required vision and hearing skills while emphasizing vestibular and tactile activities. Additionally, the prompts used were primarily physical instead of verbal prompts and the expectation of eye gaze was replaced with body orientation and/or searching behaviors to indicate attention shift. Brady and Bashinski (2008) reported that all nine children exhibited an increase in communication initiations and seven out of nine showed a decrease in the need for prompts for communicative acts. Lastly, eight of the nine participants increased the diversity of communication forms and three increased the diversity of their communication functions (Brady and Bashinski 2008).

EBPs from the Field of ASD

Three of the reviewed articles used EBPs from the field of ASD with students who had DB. The inclusion of these interventions as EBPs likely resulted in their selection from databases. One article used the Treatment and Education of Autistic and Related Communication-Handicapped Children (TEACCH) approach which utilized several different EBPs as a multicomponent intervention, one used time delay, and one used the Picture Exchange Communication System (PECS).

TEACCH Taylor and Preece (2010) used the TEACCH approach with three students who had multiple disabilities and vision impairment (VI) (one student had both VI and hearing loss and was therefore included in this review). There are four chief elements of TEACCH: physical structure (systems organizing the structure of the environment so that it makes sense to the students), daily schedules, work systems (instruments which show students activities to be completed, time necessary, and what comes next), and visual structure within activities (visual organization, instruction, and clarity which shows students how to carry out and complete tasks). Taylor and Preece (2010) adapted the TEACCH method to maximize the students' strengths and skills. Since these students could not rely upon their vision, all vision-based supports were enhanced by tactile and auditory structures in order to take full advantage of the sensory information available to them. Such adaptations consisted of using contrasting colors to encourage the use of any residual vision; auditory cues to provide interest, motivation, and to signify completion of tasks; designing tasks in such a way that only necessary pieces are included to accentuate the conception of "finished" (when all pieces are used, task is complete); and using containers to avoid pieces dropping to the floor (Taylor and Preece 2010). The students in this classroom displayed reduced aberrant behavior as well as increased communication and independence. However, the authors reported that the students who experienced the most improvements were those who displayed features of ASD. They also speculated that students who are not able to physically manipulate activities may not experience the same success.

Time Delay The concept time delay has been researched considerably in special education over the past years, especially with students who have cognitive disabilities (Browder et al. 2009; Dogoe and Banda 2009; İFtar et al. 2011). Johnson and Parker (2013) conducted a study to determine if time delay procedures were effective in helping children with multiple disabilities or DB communicate. The participants consisted of three students under the age of 11 who were reported to have multiple disabilities, including DB. There were six 10-min intervention sessions in which the child was given a prompt followed by 5, 10, and 15-s wait times. By using the wait time increments, researchers were able to determine if a child was prone to complete the activity if the communication partner waited before administering a prompt (Johnson and Parker 2013). After each intervention session, the parents of the children were shown videotapes so they could see how and if wait time aided in communication for their child. This was followed by the development of a plan for how the parents could be active communication partners with their children. The results of this intervention showed that the children were able to complete tasks at a considerably higher frequency when wait time was used before providing a prompt (Johnson and Parker 2013). Moreover, the children exhibited an increase in auditory processing and responses. These results show that wait time instruction and use may be beneficial to parents in developing their skills as communication partners as well as for increasing communicative skills of individuals with DB or multiple disabilities (Johnson and Parker 2013).

PECS PECS is an alternative communication intervention that utilizes nonverbal participation and the concepts of behavior analysis. One of the goals of PECS is to develop functional communication in children who are both verbal and nonverbal. The means through which this is developed is

through a system of augmentative communication, resulting in self-initiated communication (Bondy and Frost 1998). Individuals with DB do not use visual communication systems; therefore, a system which uses tangible alternatives must be identified (Bracken and Rohrer 2014). In their study, Bracken and Rohrer used an adapted form of PECS with three adults with comorbid DB and ID who were chosen because of their sensory impairment and lack of functional communication. The PECS cards were adapted by using raised images or enlarged colored pictures, depending on the needs and skills of the participant. The authors explained that the two participants who were completely blind were allowed to initially explore items by touch followed by moving the item slightly out of the way, but close enough that the participant knew that it was still present during phase I. It is important for the reader to know that the objective of phase I of PECS is to have the participant pick up a picture of a "highly preferred" item, reach toward the trainer, and release the picture into the trainer's hand (Bondy and Frost 1998), not simply explore the item or picture. The participant with partial sight was administered PECS in the traditional way, including error correction when required. Social praise was provided in the form of a touch on the shoulder in combination with a reinforcing item. The researchers continued in a similar manner for phase II while increasing the distance between the participant and communication partner. The last phase included in this study was phase III, which was divided into two subphases designed to teach discrimination between a preferred and nonpreferred item. The researchers indicated that results of the study showed that all three participants successfully completed all three phases as well as generalization to other settings and individuals, suggesting that PECS could be a successful method to teach communication to children who are DB (Bracken and Rohrer 2014). The results for the participants who were completely blind were questionable due to the unclear description of phase I implementation. If phase I included the blind participant only exploring the item, then that particular phase was not implemented with fidelity according to PECS procedures. However, researchers moved forward into phases II and III and the student was successful.

Discussion

While the literature is limited on potential interventions for use with the population of students with comorbid DB and ASD, there are some initial directions posited for teachers and professionals. The research presented in this review indicates that students who are DB may benefit from interventions from both the fields of DB and ASD. While the inclusion of individuals with comorbidity has been rarely seen in the literature, the implications of the reviewed interventions may be applicable to the comorbid population.

Educational Implications and Recommendations

When surveying the interventions used in both DB and ASD, one can easily note the lack of consistency between the different interventions used. However, there may be ways to bring interventions from these two fields together. Modification of EBPs from the field of ASD to meet the very unique needs of individuals with DB is one potential way to converge pools of knowledge. It is essential to keep in mind the heterogeneity of the DB population and the importance of keeping the child's needs and preferences central to any intervention chosen. Professionals could also use practices which have been utilized with individuals who are DB and apply them to some of the EBPs from the field of ASD as well. In other words, the door could swing both ways: taking knowledge from one field and applying it to the other.

One example could be the way that we interpret interventions from the field of DB. Affective communication interventions (as detailed previously) could be interpreted as a parent-implemented intervention (PII), an EBP from the field of ASD, if it were conducted using the same procedures. For PII to work well, a strong partnership between specialists and parents as well as family-centered planning is critical. Family-centered procedures involve collaborations among parents, other primary caregivers, and specialists, promoting the ideal development of the child. They also address the trepidations and priorities of families which lead to empowering the families to make meaningful decisions (Hendricks 2009). Data collection, continuous monitoring for fidelity, and retraining, when necessary, are also important when using PII. Affective communication interventions could be used as the intervention in PII. In order to do this, a professional familiar with these interventions would be required to utilize the structure of PII to train the parents/caregivers.

While some of the EBPs from the field of ASD can be used with modifications when working with individuals with DB, there are also some that may not be appropriate for use with this population. Keeping an individual-centered focus is vital when choosing any intervention, especially for individuals with DB. Overall, the use of EBPs from the field of ASD could be a boon to the field of DB if the appropriate EBPs are chosen and the necessary modifications made in order to meet the individual's distinctive needs. Individuals with DB may benefit from interventions that have arisen from the field of ASD; however, if the symptoms of ASD are caused by the sensory deprivation, it is crucial that the sensory loss and resulting consequences be the primary focus for intervention. Currently, some of the teaching strategies and interventions used in the field of DB could be interpreted to fall under various established EBPs from the field of ASD; however, there is a lack of empirical evidence which would provide the support necessary to meet the standards to scientifically qualify them for an EBP.

Practicing professionals are encouraged to not only use the strategies and interventions which have been traditionally used when working with children with DB, but to also look to other fields to identify practices which may be used to address the unique learning needs of their students. Since there is such heterogeneity between learners with DB, it is imperative that a practitioner have a full "tool box of interventions" from which to draw; therefore, confining oneself to a few strategies from one field is likely to produce frustration in both the learner and the professional when those methods are unsuccessful. Moreover, it is vital for school districts to make available ongoing professional development to all staff regarding EBPs and their use in the classroom so that those providing services to this unique population have a strong foundation for additional teaching methods and interventions.

The goal of any professional in the area of special education should be for increased quality of life, independence, and the best education possible. Determination of whether or not an individual has comorbid DB and ASD through differential diagnosis is not the ultimate issue. With the concurrent growth of ASD and controversy over the possible comorbidity of the two, this review sought to further the conversation as well as provide some educated suggestions.

As the prevalence of ASD in individuals with no additional disabilities grows, it is not unlikely that the disorder could be present in individuals with DB as well; however, great care must be taken when differential educational diagnosis is attempted and should only be considered as a last resort. While the controversy over the comorbidity of DB and ASD has led some researchers to produce literature on the subject, there still exists a dearth of information, including, but not limited to, diagnostic procedures, EBPs, and directions for educational practices. Whether an individual has ASD in conjunction with DB or not, teachers who serve individuals with DB have few EBPs from which to refer when planning educational programming. Additionally, the number of professionals knowledgeable about DB as well as comorbid DB and ASD is quite negligible.

It is imperative that more individuals are trained in the area of DB. The shortage of qualified personnel to provide appropriate support to the students, caregivers, school districts, and service agencies for individuals who are DB results in unmet needs and the lack of educational progress. If more proficient specialists were generated, it is likely that the quality of life for individuals who are DB, as well as their families and communities, would benefit greatly. Furthermore, these specialists would have the necessary skills to conduct assessments and make modifications to interventions which would better meet the needs of these individuals.

The process for educational identification of comorbid ASD with DB should not be undertaken by someone only trained in the area of ASD. The endeavor should be undertaken by a team of individuals who are authorities in, at the very least, ASD *and* DB in order to obtain a valid appraisal. Because of the overlap in the aforementioned characteristics, any assessments to this end should only be embarked upon after much observation by well-trained professionals in the area of DB so as to identify, if possible, the source of the child's difficulties. A diagnosis of ASD in a child with DB should never be the first step when attempting to identify a child's struggles.

It is suggested that educators look to the field of ASD to acquire EBPs which could be modified to meet the needs of their students, whether they are diagnosed with comorbid ASD or not. Since students with DB struggle with many similar delays as those with ASD, practices which have proven useful with individuals with ASD could also, with appropriate modifications, prove successful with students who are DB. Future consideration should be made by researchers in the field of DB to identify and modify appropriate interventions from other fields within the scope of special education due to the fact that many current practices within the field of DB are, while good, not yet considered EBPs. By "marrying" interventions from the field of DB with those recognized as EBPs from other fields, the pursuit of EBPs within the field of DB could be hastened.

Further research should focus on replication of previous studies which have shown promising results (i.e., Bracken and Rohrer 2014; Bruce 2005a; Wheeler and Griffin 1997) while addressing limitations of the studies (such as replication of effect, generalization across environments, and maintenance) as well as research rigor (inclusion of psychometric information such as reliability, validity, and/or fidelity). Recently, literature has been published which addressed the use of single-subject research to establish an intervention as an EBP. Horner et al. (2005) delineated the standards used to evaluate single-subject research results when using them to document EBPs. According to Horner et al., a study must meet the following criteria before an intervention can be established as an EBP: operational definition of the practice and context, fidelity of implementation, documentation of functional relationship, and replication of the effect over a number of studies. It is suggested that future research use this rigorous criteria when seeking to replicate studies. Additionally, researchers are encouraged to investigate the modification and use of EBPs from the field of ASD, either in combination with interventions used in the field of DB or alone. Furthermore, it would behoove researchers to further examine the effectiveness of measures used for differential diagnosis and how to modify existing ASD diagnostic tools. Finally, researchers and practitioners are implored to consider the effects of sensory loss on the learner and effectively address those before attempting to diagnose ASD in learners who are DB.

Compliance with Ethical Standards This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest All authors declare that they have no conflict of interest.

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